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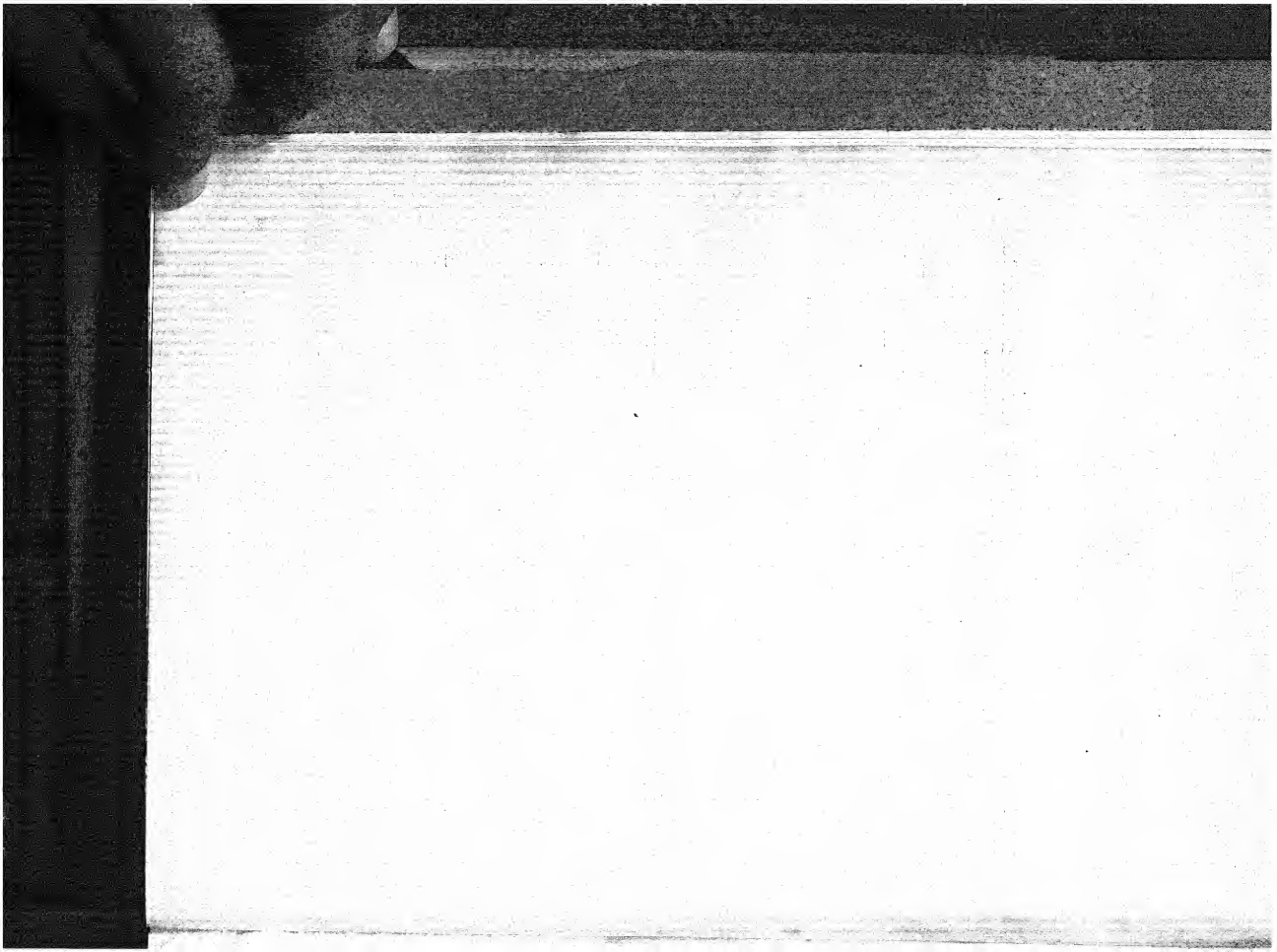

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Vol. XXVII, Part IV

(December, 1957)

THE INCIDENCE OF SURRA AND TABANID FLIES IN RAJASTHAN*

By P. Balarama Menon†, Indian Veterinary Research Institute, Izatnagar, U.P.

(Received for publication on May 11, 1956)

(With 3 maps and one Text-fig.)

THE data which form the subject of this article were collected during a tour of Rajasthan and Ajmer undertaken in March, 1954 to study the incidence of tabanid flies and surra in that north-western dry region of India. The Rajputana states constituting the present State of Rajasthan form an important camel rearing area with scanty rainfall (Map 1). Surra is a serious disease of horses and camels and tabanids are the suspected common transmitters of this disease. But, so far, no information regarding the incidence of the disease or its transmitting agents is available from Rajasthan. Senior-White [1927] while cataloguing the Indian species of *Tabanidae* remarked that not a single record of these flies was available from Rajputana. Basu [1945] reported on the distribution and seasonal incidence of surra in India and prepared a map showing the intensity of surra in various parts of India. Though it was clear from the map that the disease was prevalent more or less throughout India, the area covered by the states of Rajputana had to be left completely as no information regarding that area was available. Hence it was considered necessary to collect the data regarding the incidence of surra in Rajasthan and also to investigate the vector problem in the area.

The present Rajasthan State was formed in the year 1950 by integration of about 20 small states of Rajputana. The State now comprises five major Divisions, viz. Jaipur, Jodhpur, Bikaner, Udaipur and Kota (Map II). The climatic and meteorological conditions vary considerably in the different Divisions. There is a common belief outside Rajasthan that it is one arid rainless desert and, since moisture and parasitic life go together, the animals of Rajasthan are free from most of the parasitic diseases. But the whole of Rajasthan is not a waterless desert with scanty rainfall (Table I). Certain areas have fairly good rainfall and many have large stretches of perennial water lakes. Certain other areas are canal irrigated (Pali and Ganganagar). The south and south-east regions have fairly heavy rainfall and the north, east and north-east have the same climate and topography as Uttar Pradesh and Madhya Bharat. Only the western parts with Bikaner and some portion of Jodhpur Division are dry and arid (Map III).

Rajasthan has 75 per cent of the camel population of India. They are distributed throughout the State but are found in large number in the west and south-west Rajasthan. In addition to about 3½ lakhs of camels, the region has a large population of horses, donkeys and cattle.

* Paper read at the 42nd Session of the Indian Science Congress at Baroda, 1955.

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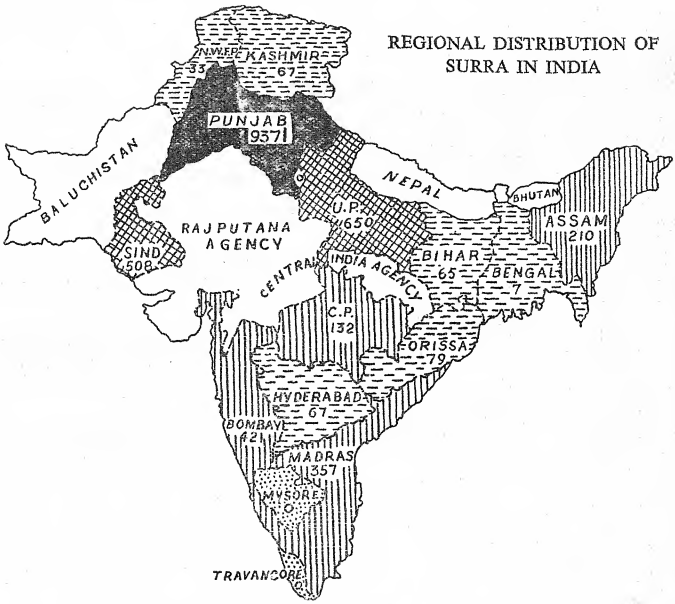
Ajmer is a small State surrounded on all sides by Rajasthan with similar topography and climate. The breeding places for tabanid flies are mostly big tanks, as there are no canals. The average annual rainfall in the area is about 20 inches. Livestock census for Ajmer State for 1952 shows 3,32,421 bovines, 1,530 horses, 4,659 donkeys and 1,781 camels. In Ajmer State camel breeding is not carried out on such a large scale as in the south and south-western parts of Rajasthan.

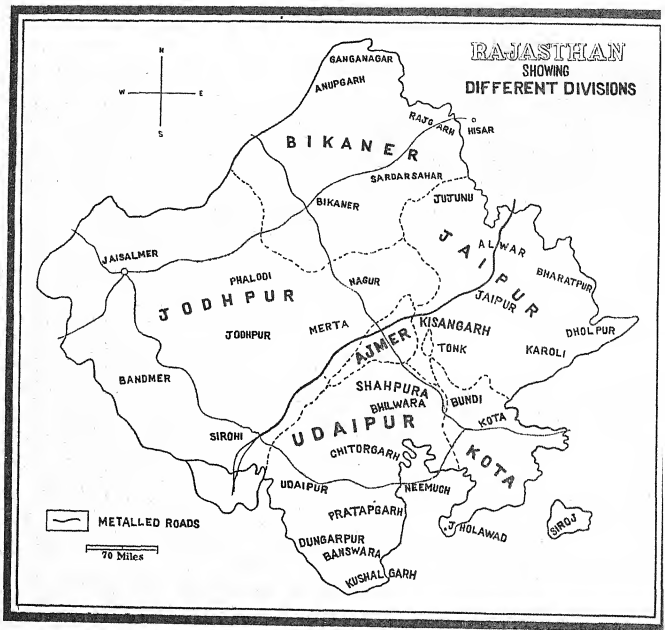
INCIDENCE OF SURRA

Surra is the most important of camel diseases and the present investigation has shown that its incidence is very high in Rajasthan. It is believed that since the introduction of antrypol the disease has been under check. It usually runs a chronic course among camels extending even to three years. It is locally called '*Thribursa*'; it weakens the animal at every relapse and finally proves fatal. Cases of surra reported from the different districts of Rajasthan in an average year are given in Table II. The figures for the incidence of camel surra are available for all the districts except Banswara and Dungarpur. The figures represent average of four years for each district. It is seen that on an average every year about 6,000 surra cases among camels are treated in the veterinary dispensaries of Rajasthan. These figures are likely to be smaller than the actual number of cases, as many of the cases receive private treatment and are not included in hospital records. Besides, a large number is treated by the *Rubbaires* themselves as the drug antrypol and its method of administration are well known to them [*Progress Report of the V. I. O.*, Rajasthan and Ajmer, Sankarnarayan, 1953-54]. Table II shows that though surra is prevalent throughout Rajasthan it is a scourge more in the southern districts. With its average number of 1,555 cases per year Pali has the greatest incidence of camel surra with the adjoining district of Udaipur coming next. These two districts have a number of tanks, lakes and canals with overhanging vegetation offering excellent breeding places for tabanid flies. Having extensive jungles and cultivation, these two districts afford good grazing and hence a large number of camels are bred and kept in these areas. Bikaner which is a very dry area is almost free from surra though it has a large camel population. Ganganagar which is adjacent is, on the other hand, largely canal irrigated and shows a fair incidence of surra.

Seasonal variation. Table III shows the number of surra cases (in camels) treated at the City Veterinary Hospital, Udaipur, during three years from 1951 to 1953, during different months. From this Table, as well as the previous one, it is clear that the number of surra cases is on increase in the months following the monsoon rains and that the climax is reached during September, October and November when the fly breeding is also supposed to be at its zenith following heavy dains in July and August (Graph 1). The incidence continues to be high during rhe early part of the winter and gradually declines towards summer and is the lowest turing April and May when the water sources are dried up and fly breeding completely stops. Hospital records from Pali also show the incidence of surra, mostly in camels, throughout the year excepting the hot months of April, May and June. Cases are recorded even in extreme winter months of January and February.



MAP I—Number of surra cases reported during the years 1940-42. (After Basu, B. C. (1945))



Map II—Political map of Rajasthan showing the different Divisions

TABLE I

*Showing the average annual rainfall in inches in different months of the year at representative stations in Rajasthan (average of three years, 1951 to 1953)**

Station	Months of the year												
	January	February	March	April	May	June	July	August	September	October	November	December	Total
Jaipur	0·33	0·17	0·07	0·17	0·33	0·74	9·22	7·68	2·76	0·03	0·00	0·00	20·50
Jodhpur	0·04	0·02	0·00	0·04	0·11	0·92	7·10	4·81	1·79	0·00	0·00	0·00	14·83
Udaipur	0·87	0·09	0·01	0·35	0·05	3·87	10·70	6·90	2·04	0·07	0·50	0·00	25·45
Kotah	0·12	0·06	0·05	0·02	0·16	3·58	11·26	7·13	3·53	0·00	0·00	0·07	25·98
Bikaner	0·24	0·10	0·15	0·00	0·10	0·60	4·43	5·35	0·51	0·00	0·00	0·00	11·48
Total	1·60	0·44	0·28	0·58	0·75	9·71	41·71	31·87	10·63	0·10	0·50	0·07	98·24
Average	0·32	0·09	0·06	0·12	0·15	1·94	8·34	6·37	2·13	[0·02	0·10	0·01	19·65

* Based on data supplied by the Indian Meteorological department.

TABLE II

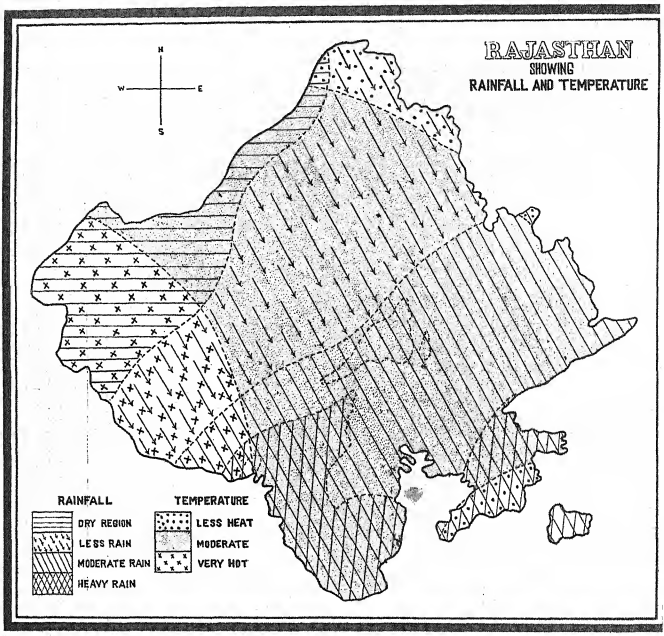
Number of surra cases reported from different districts of Rajasthan in one average year (average of 4 years)

Name of Districts	Months of the year												
	January	February	March	April	May	June	July	August	September	October	November	December	Total
Udaipur	26	33	42	9	14	24	67	202	78	288	249	67	1,103
Chittor	8	..	3	3	2	51	10	15	4	43	29	74	242
Bhilwara	15	27	18	7	24	16	35	23	16	15	38	35	264
Kota	42	5	2	6	3	2	4	4	162	2	5	129	366
Bundi	18	32	35	18	30	32	7	13	171	96	39	10	501
Jhalawar	2	1	3	31	4	7	2	1	8	4	4	5	72
Jaipur	..	..	..	..	..	..	..	..	..	..	2	..	2
Dausa	..	..	1	1	..	..	..	..	..	..	..	..	2
Sawai Madhopur	..	1	..	1	1	..	3	..	2	..	..	2	10
Bharatpur	1	1	..	..	..	..	1	..	1	..	2	4	10
Rajgarh	1	1	3	..	1	..	2	2	10	4	8	6	38
Kishengarh	1	1	2	1	..	1	1	21	6	13	3	5	56
Alwar	3	3	6	1	2	..	3	3	3	6	2	3	31
Jodhpur	15	12	5	7	9	8	17	86	64	89	94	30	406
Nagaur	22	13	14	18	10	14	22	51	37	83	66	30	380
Pali	36	169	9	22	24	94	68	117	220	404	163	120	1,555
Jalore	23	8	5	13	1	7	36	24	54	258	111	65	605
Barmer	1	5	3	..	5	10	11	2	22	23	2	5	89
Bikaner	1	1	..	..	..	..	..	1	1	1	1	2	8
Ganganagar	14	22	12	7	16	16	24	25	11	51	31	33	266
Total Rajasthan	229	235	160	145	145	282	313	590	979	1,376	819	630	6,006

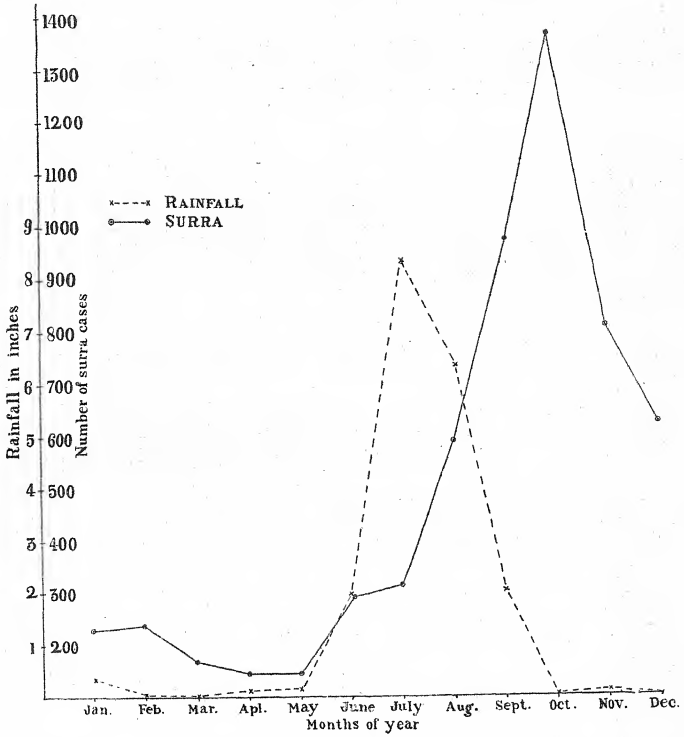
TABLE III

Surra cases in camels treated at the City Veterinary Hospital, Udaipur, for 3 years, from 1951 to 1953, month by month

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1951	54	95	121	5	..	..	20	1	4	9	3	15	327
1952	30	1	1	..	..	..	40	75	40	10	219	138	554
1953	1	7	3	..	25	10	6	14	6	145	65	..	282
Total	85	103	125	5	25	10	66	90	50	164	287	153	1,163



MAP III—Meteorological map of Rajasthan showing temperature and rainfall



GRAPH I—Showing relation of rainfall to the incidence of surra

Distribution

The disease is found more common in moist regions, viz. eastern half of Rajasthan including eastern half of Jodhpur Division. Udaipur and Kota are the two Divisions affected most. Since camels of the arid region of Jodhpur and Bikaner Divisions come in contact with the diseased ones when taken for foraging, they get the infection during the fly season. Hence cases of surra are not uncommon in Jodhpur and are only occasionally reported from Bikaner Division.

Surra cases are also reported from the State of Ajmer. From the reports available, the number of camels treated for surra in the State during 1951-52, 1952-53, and 1953-54 is 28, 238 and 51 respectively. But it is, however, doubtful whether all these were local cases. Majority of them were believed to be from camels brought from outside the State, i.e. from Rajasthan which surrounds it on all sides. Complete figures for surra are not possible as some cases receive private treatment and are not included in the hospital records.

The above statement shows that surra is very much prevalent in Rajasthan and Ajmer and is as much a serious problem there as elsewhere, perhaps as camels are highly susceptible to the disease and Rajasthan is the most important camel breeding centre in India.

THE VECTOR PROBLEM AND THE INCIDENCE OF TABANID FLIES

It has been established that tabanid flies are primarily responsible for the transmission of surra. These flies are common in India and Basu, Menon and Sen Gupta [1952] have dealt with their detailed distribution. All the common species are blood-thirsty and voracious biters, being able to puncture the thick skins of equines and bovines in a few seconds and to cause an abundant flow of blood upon which the females become engorged. Warm blooded animals, including man, are subject to their persistent and unrelenting attacks. The adults are strong fliers and occur abundantly in the neighbourhood of water. They lay their eggs generally on leaves and stems of plants overhanging the water. After hatching, the larvae fall into the water and develop. When mature, they crawl to dry soil, pupate and after a few days emerge as adult flies [Basu *et al.*, 1954].

In the absence of water and sufficient atmospheric humidity tabanid flies cannot breed and survive, and since these flies act as mechanical transmitters of *Trypanosoma evansi*, the causal organism of surra, transmission of the disease cannot take place. Since surra cases are seen throughout Rajasthan, fly breeding must also be taking place. If surra cases are common in a locality even in the absence of these flies, there must be some vectors other than the tabanid flies. It has therefore, been, suggested that in portions of Rajasthan with scanty rainfall and dry and arid conditions, tabanids can not be a problem and that the transmission of surra must be taking place through the agency of some other vector. In fact, Cross and Patel [1921] reported transmission of surra by the ticks, *Ornithodorus crossi* and *O. lahorensis*, but their findings have not so far been confirmed. Sankarnarayan [1948-50] found that camel ticks were incapable of

transmitting surra. The author also has failed to transmit surra in the laboratory through the agency of ticks (unpublished). Since it is only a mechanical transmission without the parasite undergoing a development or cyclical changes inside the vector's body, it naturally follows that such transmission through bite from an infected animal to a healthy one should take place within a short period of time. So unless there is a developmental phase inside the ticks, it may not be possible for them to act as transmitters, as ticks do not move quickly from one animal to another for their feed. Biting flies alone are capable of doing it on account of interrupted feeding as those flies visit many animals in a herd in quick succession.

During the present investigation it has been found that tabanid flies are present in all the Divisions of Rajasthan and they can breed and complete their life-cycle under the conditions prevailing there. During the present survey it has been possible to visit all major water collections in different parts of the State and to collect all stages of the fly, viz. the egg, larva, pupa and adult (Table IV). Large numbers of egg masses were collected from several lakes and ponds in all the Divisions except Bikaner from where only very few batches of eggs could be obtained. It had not been possible to visit Sri Ganganagar and other canal irrigated areas in Bikaner Division which may provide conditions suitable for the breeding of tabanid flies. Adult flies were caught while laying eggs on subaquatic vegetation and also while feeding on camels. Among the adults collected and identified, four species were found, viz. *Tabanus rubidus* Wiedemann, *Tabanus striatus* Fabricius, *Tabanus macer* Bigot and an undetermined species of *Atylotus**. It may be mentioned here that Basu *et al.*, [1952] reported 17 species of *Tabanus* from the north-western dry region of India in which Rajasthan is included and from where no record was available till then. Hence the four species of tabanids collected from Rajasthan during the present investigations, are new records for the locality. It may also be mentioned that *T. rubidus* is a well known carrier of surra and that *T. macer* is also one of the seven species of *Tabanus* which have been incriminated in the transmission of the disease.

TABLE IV

Breeding places of Tabanus *flies in different parts of Rajasthan visited during the survey*

Locality	Source of water	Tabanid breeding	Remarks
1	2	3	4
Jodhpur	Mandour canal catchment area	No breeding	With overhanging vegetation
Jodhpur	Balsamand (lake)	—*nil*—	No vegetation. Entire rocky edge
Jodhpur	Takhatsagar (lake)	Fairly heavy breeding in isolated places. Egg batches mostly recent and some freshly laid	Isolated pockets with bamboo grass vegetation, both floating and emergent. Signs of animals frequenting the place

* Identified by the Commonwealth Institute of Entomology, British Museum, London.

TABLE IV (contd.)

Breeding places of Tabanus *flies in different parts of Rajasthan visited during the survey*

Locality	Source of water	Tabanid breeding	Remarks
1	2	3	4
Jodhpur	Sardarsamand (lake)	Many old egg batches found on a few dry *Acacia* plants standing in water and a few batches on *casurina* and *calatropis* plants in canals taking from the lake	No marginal overhanging vegetations; only rocky stones and boulders at the edges. These large lakes are not potential breeding places but the canals taking from it with plentiful grass and other vegetation are likely breeding places
Pali	Irrigation canal	Fairly heavy breeding on both the banks	From Sardarsamand to Pali the canal running with plenty of vegetation
Pali	Pali lake	—*nil*—	Scanty emergent vegetation
Udaipur	Fateh sagar and Saroop sagar (lakes)	Breeding present in sheltered pockets on grass, etc. overhanging water	Irrigation canals from the lakes also breeding
Udaipur	Pichola lake	No breeding	Sides of the lake are pucca built and hence no breeding can take place
Udaipur	Udaisagar lake and the *nullah* falling into it	Heavy breeding. Bunches of eggs. Many larvæ collected from the edge of the nullah	Potential breeding places. Plenty of reeds and grass. Ideal place for breeding
Chittorgarh	Gambhir Nadi (River)	Heavy breeding especially on round grass *Scirpus*	Not much water with emergent grass. Eggs abundant on both the banks a little farther down the bridge
Chittorgarh	Gomukhi Kund (Drinking water supply in the fort)	No breeding	No emergent vegetation. *Algæ* present
Ajmer	Budda Pushkar (lake)	Fairly heavy breeding Many egg batches collected. Flies collected from camels in the locality	Plenty of grass and vegetation. Potential breeding place after rains

TABLE IV (contd.)

Breeding places of Tabanus *flies in different parts of Rajasthan visited during the survey*

Locality	Source of water	Tabanid breeding	Remarks
1	2	3	4
Ajmer	Pushkar (lake)	No breeding	Steps of stone leading into the lake on all sides. No possibility of breeding excepting in a small patch in a corner where some grass is growing
Ajmer	Anasagar (lake)	No breeding	Lake with extensive catchment area and a stone and marble built embankment on one side. Possibility of breeding on the opposite side where grass, etc. are growing
Ajmer	Pisangan tanks	No breeding	No marginal vegetation
Kota	Kota tank	A few eggs collected	Marginal vegetation confined only to small patches on the south-west corner of the tank, rest being stony sides
Kota	Chambal river	No breeding	Plenty of water but no vegetation near about. A possible source of breeding
Jaipur	Jal Mahal tank	Heavy breeding in small patches. Many bunches of eggs collected from a dry *babul* twig standing in water and some on isolated grass blades. Many adults caught while laying eggs	No marginal vegetation; Water saltish; cattle grazing nearby

TABLE IV (concld.)

Breeding places of Tabanus *flies in different parts of Rajasthan visited during the survey*

Locality	Source of water	Tabanid breeding	Remarks
1	2	3	4
Jaipur	Amber tank	No breeding	Water dry
Jaipur	Rawalji-ka-Bandha (tank)	Fairly heavy breeding	Plenty of marginal grass. Ideal place for breeding with water and abundant vegetation and elephant grass
Jaipur	Babuji-ka-Bandha (small tank)	No breeding	Without much vegetation. Cattle grazing nearby. No adults found
Bikaner	Devikund and Devikund Sagar (tanks)	Evidence of breeding; old egg shells on a creeper overhanging water	Both the tanks are bereft of vegetation except a patch on the eastern side of Devikund. Eggs were found on old projecting twigs. Both the tanks dry up in summer
Bikaner	Kodamdeshar tank	No breeding	No vegetation

From the statement given above (Table IV) it is clear that even the dry Bikaner is not free from tabanids. This survey was undertaken in the month of March when most of the sources of water were expected to be dry. After the monsoon, when all the tanks are full and there is plenty of vegetation at the banks, fly breeding in these areas is expected to be heavy and this has been proved by the high incidence of surra in post-monsoon months (Table II). It is reasonable to presume that a more detailed survey carried out in the post-monsoon months in Rajasthan may reveal the presence of some more species of tabanids. Since *Tabanus* flies are present in Rajasthan in a sufficient number it is only reasonable to suppose that, as in other places, transmission of surra is taking place in these areas through the agency of these flies.

EGG PARASITES OF TABANUS

It is known that the eggs of *Tabanus* flies are sometimes parasitised by other insects. Menon [1954] reported on a new species of *Telenomus* (Scelionidae : Hymenoptera) destroying large numbers of egg masses of *Tabanus* flies in certain villages around Izatnagar (U.P.). During the course of the present survey, among

the large numbers of egg masses collected from different Divisions of Rajasthan, it was observed that some of the batches of tabanid eggs obtained from Jal Mahal tank in Jaipur were parasitised and when they were kept in a moist chamber, large numbers of small hymenopterous insects were found emerging from them. These parasites appeared quite different from the species of *Telenomus* reported from Uttar Pradesh. The insects which emerged from the eggs collected from Jaipur were sent for identification and confirmation to the Commonwealth Institute of Entomology, London, and have been identified as belonging to an indeterminate species of *Centrodora* of the family Encyrtidæ (Hymenoptera). This appears to be the first record of this species parasitising eggs of tabanid flies in India. It was not possible to determine what species of Tabanidæ the parasitised eggs belonged to, but it was probable that they may be of *Atylotus* which were found laying eggs on grass in Jal Mahal tank in Jaipur from where the infected egg masses were collected. Many adults of *Atylotus* were collected while in the act of oviposition from the same site and no other species was in evidence at that time. The possibility of utilising these parasites in the biological control of tabanid flies is yet to be investigated.

Summary

This report presents for the first time, data regarding the occurrence of surra and tabanid flies in Rajasthan and Ajmer. Though the area is generally dry, surra is prevalent in camels in Rajasthan. There is an increase in the incidence of surra in the post-monsoon months reaching the climax in October and November when the fly breeding is also expected to be at its highest. The incidence continues during the early part of winter and gradually declines towards summer and is the lowest during April and May when the water sources are dried up and fly breeding is completely stopped.

The disease is more common in the moist regions, viz. eastern half of Rajasthan including eastern half of Jodhpur Division. Udaipur and Kota are the two Divisions affected most. Pali has the highest incidence of surra recorded so far. Since camels of the arid region of Jodhpur and Bikaner Divisions come in contact with the diseased ones, when taken for foraging, they get the infection during the fly season. Hence cases of surra are not uncommon in Jodhpur and Bikaner Divisions also. Surra cases are also reported from Ajmer but the majority of them are believed to be from camels brought from outside the State.

A tabanid survey was conducted in the area with special emphasis on the breeding places and it was established that the transmission of surra took place in the area through the agency of the flies which were present, in all the Divisions of Rajasthan and Ajmer and which could breed and complete their life cycle under conditions prevailing there. Even "waterless" Bikaner with an average annual rainfall of 7 to 8 inches was not free of them. Large numbers of the different stages of these flies, viz. egg, larva, pupa and adult, were collected from different Divisions and four species of Tabanidæ, viz. *Tabanus rubidus*, *T. striatus*, *T. macer* and an undetermined species of *Atylotus* have been recorded. These are new records for the locality.

Centrodora sp. (Hymenoptera : Encyrtidæ) is recorded for the first time as a parasite of the eggs of tabanid flies in India. It had been possible to breed these parasites into adults in the laboratory when the infected egg batches were kept in a moist chamber. The possibility of its utilisation in the control of *Tabanus* flies is suggested.

ACKNOWLEDGMENTS

The author expresses his thanks to the Director of Agriculture, Rajasthan and the Director of Animal Husbandry, Ajmer, for giving him all facilities during his tour of their States and providing him with surra incidence and livestock census figures. He also thanks Mr. N. S. Sankarnarayan, Disease Investigation Officer, Rajasthan and Ajmer, for all co-operation and help extended during these investigations. He is grateful to Dr H. D. Srivastava, Head of the Division of Parasitology, I.V.R.I., Izatnagar, for his keen interest and on whose suggestion this piece of work was undertaken.

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SEMINO-VESICULITIS IN A BULL AT AN ARTIFICIAL INSEMINATION CENTRE

By MAHENDRA PRATAP JOHARI, College of Veterinary Science and Animal Husbandry, Mathura

(Received for publication on May 10, 1956)

(With two Text-figs.)

THE affections of the male sex organs in bulls which are quite common may be due to specific or unspecific causes. The inflammation of the part, e.g. orchitis, epididymitis, ampulitis, seminal vesiculitis may be there with or without the formation of abscess. In cattle, the specific causes have generally been attributed to *Brucella abortus ; Streptococci; Bacillus pyogenes* and *Bacillus tuberculosis*. These affections often lead to sterility and become a source of infection to the cows served or artificially inseminated.

Anamnesis

The bull No. 80/P15 of Sahiwal breed aged about 4 years stationed at Jaisinghpura in district Sultanpur was received at the Centre on April 6, 1955 from a Government Farm in Lucknow where preliminary training for making collections in the A. V. was given. At the Artificial Insemination Centre the bull was maintained under optimum conditions of food and management. Its daily ration consisted of 9 seers of *bhusa*, ¾ seer of crushed gram, ¾ seer of crushed barley, 1 seer of mustard cake and 1 chhatak of common salt. In addition, to the above, green fodder was also given. The bull was given 6 miles walking exercise in the morning and 3 miles in the evening. The bull had a good sex desire, generally took 5-10 minutes to serve, the seminal volume was 2-6 ml. and initial motility 3. The semen was seen to deteriorate rapidly, was greenish in appearance and watery in consistency. After about two hours, it was not fit to be used for artificial insemination work.

From April to September 1955, 27 semen collections were made. During this period 33 inseminations were carried out, 15 out of which were supposed to be pregnant at 90 days' non-return basis. The Veterinary Officer, incharge of the Artificial Insemination Centre, reported the matter to the Regional Sterility Officer, Uttar Pradesh. On receipt of the report, the author examined the bull on December 13, 1955.

General clinical investigation

The bull looked healthy, in good condition and showed a lively temperament. Skin, palpable lymph glands and visible mucous membrane were found normal. Body temperature was not taken.

Special clinical investigation

Circulatory, respiratory, digestive and nervous systems showed nothing of interest. Locomotion was normal.

Urinary system. Percussion and rectal palpation of the kidneys revealed nothing but no laboratory investigation was carried out.

Genital organs. Penis, prepuce, preputial ring were normal. Palpation and inspection of the testicle and epididymis gave a healthy appearance. The testicles were found to be soft, smooth, firm and free from any hardness or induration and were freely moveable in the scrotum. The head, body and tail of the epididymis did not show any abnormality. The function of the cremaster muscle was found normal as the testicles moved up when the animal was taken out from the shed.

The accessory sex organs were palpated per rectum. The prostate as a circular band, was found normal. The seminal vesicle of the left side at its proximal end was found to be tense and slightly hard, had lost the lobulated structure and there was a swollen area of ping-pong ball size. It appeared that the condition had passed to a sub-acute, chronic stage. The seminal vesicle, the ampullae of the vasa deferens on the right side appeared to be normal.

Sexual desire and serving ability were quite normal. It took good interest in the females and was above the average for sex desire and serving ability for the breed.

Examination of semen

The slides from the semen collected on January 3, 1956 and February 25, 1956 were examined. The former sample contained a lot of epithelial casts, free protoplasmic drops and the abnormal spermatozoa were 10 per cent mostly tail abnormalities. The latter sample showed improvement. There were less epithelial casts and free protoplasmic drops. No bacteria could be found in the films and cultural examination was not carried out for want of adequate facilities.

Special sero-agglutination test

Agglutination test was carried out by the Veterinary Investigation Officer, Livestock Research Station, Mathura on the serum from this bull against brucellosis. The test proved negative.

Discussion

The report of the Artificial Insemination Veterinarian that "the semen could not be preserved even for two hours" led the author to suspect that there was some pathological condition in the genital organs. The investigation revealed such a condition in vesiculae seminalis. Careful examination during acute illness would have revealed specks of pus in semen, visible in ordinary day light. Microscopic examination of stained films would have shown leucocytes, epithelial debries and possibly pathogenic organisms as well. The semen was examined on January 3,

1956 and February 25, 1956 (after 10 months of sickness) when the animal had recovered and so nothing of interest was found in the specimen. Such disorders, are comparatively common in bulls in other countries and they are readily diagnosed. In our country, they have not been recorded so far. The seminal vesiculitis, according to various authors, does not cause any disturbance in the general condition unless the inflammatory process spreads to the peritoneum, in which case the animal would show symptoms of peritonitis. According to Lagerlof, Hedstrom and Hoflund [1942], the bull's capacity to copulate is not affected whereas the capacity to fertilise is reduced or completely suppressed. In such particular case, the percentage of conception will be much below the normal but the sex desire will not, in any way, be adversely affected.

The diseases of the seminal vesicles in bulls have been studied by Gilman [1922], Williams and Savage [1925], Williams and Bushnell [1941], Lagerlof [1938, 1942] and Blom [1947]. They have observed that micro-organisms such as *Streptococci, Bacillus pyogenes, Brucella abortus, Bacillus tuberculosis* may be responsible. The role of the bull in the transmission of *Brucella abortus* infection has been extensively studied by Birch and Gilman [1926], Seagsvold [1927], Thomson [1936], Jepsen and Jorgensen [1938], and vesiculitis was shown to be of special importance in this respect.

Lagerlof *et al.*, [1942], consider that the diagnosis should be based or confirmed on palpation of the seminal vesicle and feel that owing to the emission of the infectious matter with the semen, bulls suffering from seminal vesiculitis may become dangerous transmitters of infection, within a herd or between different herds.

Diagnosis

The clinical diagnosis made by examination of the Sahiwal bull No. 80/15 revealed seminal vesiculitis on the left side. The present findings explain the cause of the rapid deterioration of semen during preservation.

A schematic picture of vesiculae seminalis of a healthy bull and a normal sample of semen is given in Fig. 1. In the Sahiwal bull the abnormality that was seen is depicted in Fig. 2 with corresponding change in the semen from the diseased bull.

Prognosis

The natural power of repair in the seminal vesicle is limited. The secretory activity of the affected part is lost depending on the severity of damage and fertility is likely to be affected.

After a long rest, in exceptional cases, symptoms may improve, the semen quality may become normal but the area affected would become fibrosed and lose its functional activity. There is always a danger for the recurrence of the trouble.

Treatment

For preventing such diseases better sex-hygiene has to be followed at the artificial insemination centres and at training establishments for bulls. Bulls selected for artificial insemination work should not be allowed to have natural service on account of the risk of contracting infection by this practice.

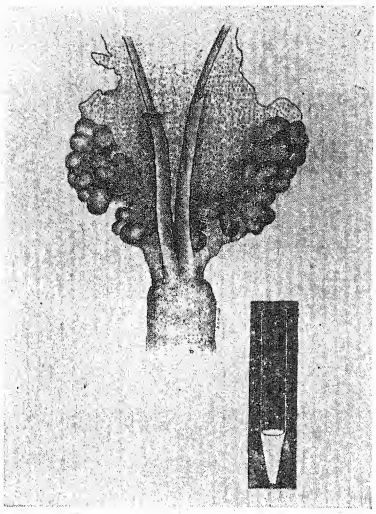

FIG. 1
A schematic picture of the seminal vesicles in Sahiwal bull and the healthy semen

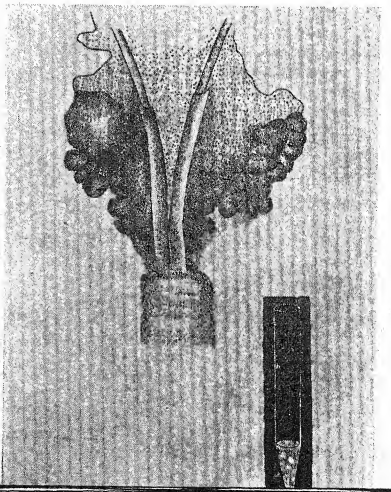

FIG. 2
Diseased seminal vesicle as seen in the Sahiwal Bull No. 80/P15 and the semen during acute illness

If curative treatment has to be done and the disease is diagnosed very early, sulphanilamides may be tried in streptococcal infections. Antibiotics like penicillin or streptomycin may be used either singly or in combination. A daily subcutaneous injection of 5 mg. dihydrostreptomycin sulphate per Kg. body weight in 50 per cent solution in water for 3 days may be tried. According to Williams [1943], there is no known remedy for established diseases of the testicles, i.e., epididymis, ampullae of the vase differentia and the seminal vesicles. The only way of safety is to discard the defective sire.

The Veterinary Officer reported on April 10, 1956 that the semen of the bull returned to normal, could be preserved for three days and that he did not find any difference, on palpation, between the right and the left seminal vesicle.

It appears that the bull contacted the disease some time in March/April in the previous year as it was since then that it was giving abnormal semen. It took him one year to recover and return to normal.

ACKNOWLEDGEMENTS

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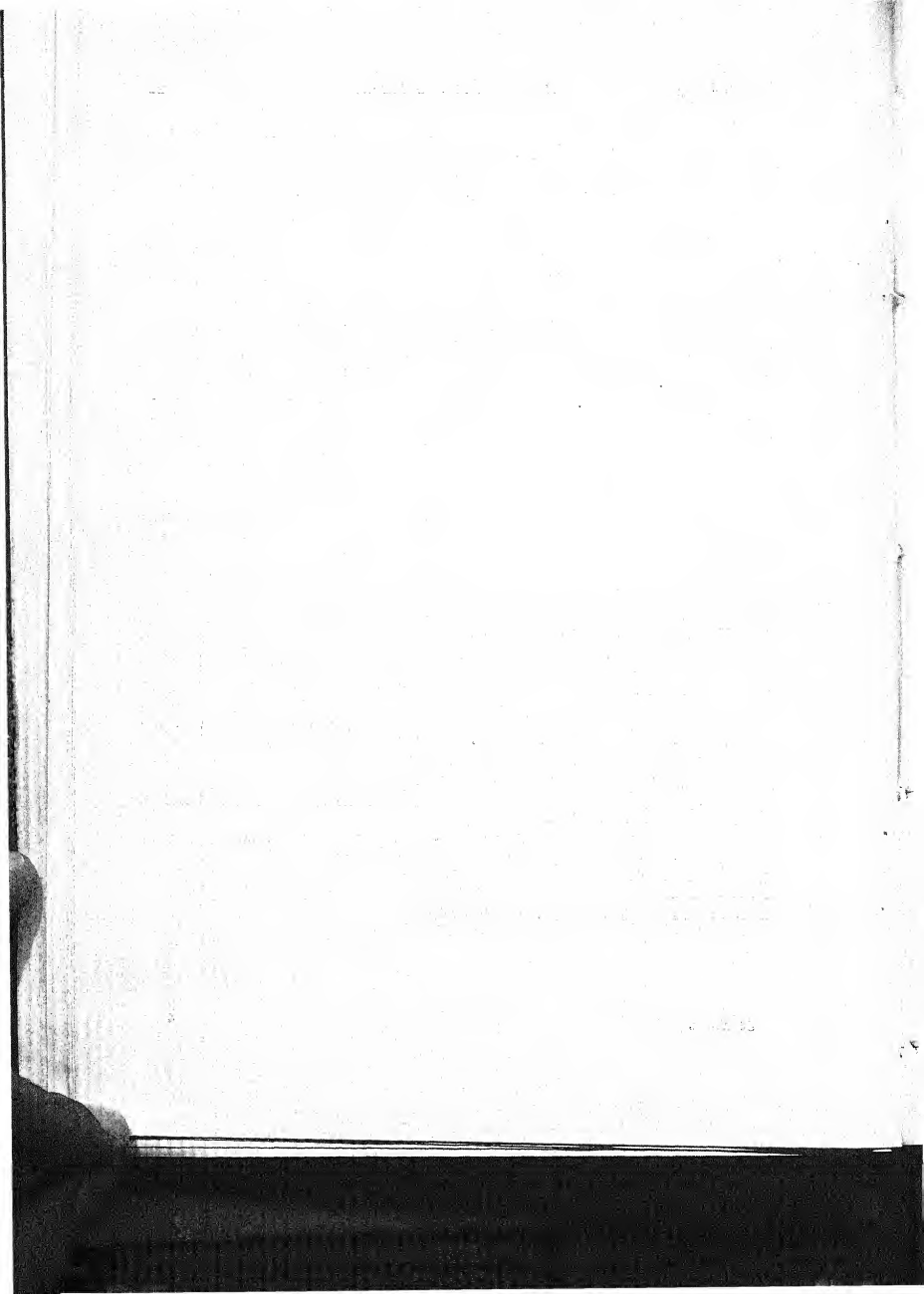

FACTORS AFFECTING GESTATION LENGTH IN HARIANA CATTLE

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THE knowledge of the length of gestation period is of importance to a cattle breeder as it helps him to prepare the prospective dam for calving and subsequent lactation. It also aids in settling cases of disputed parentage where a cow may have been bred to two different bulls at different heat periods and the calving date does not correspond to either service date.

Investigations carried out by different workers reveal the influence of some factors responsible for the variations in the gestation period. Studies made by Jafar *et al.*, [1950] in Wisconsin dairy herd, Ragab and Asker [1951] in Egyptian cattle, Jordao *et al.*, [1951] in Brazil cattle, Brakel, Rife and Salisbury [1952] in Ohio dairy herd, Arunachalam *et al.*, [1952] in Bangalore dairy herd indicated that there was a positive correlation between gestation period and birth weight in cattle. Sex of the young was found to have an effect on gestation length in different breeds of cattle as reported by Jafar *et al.*, [1950], Choudhry and Sinha [1951], Lambardt [1951], Jordao *et al.*, [1951], Burris and Blum [1952] and Lazarus and Anantakrishnan [1952]. No effect of sex was observed in Egyptian cattle [Ragab and Asker, 1951] and in Murrah buffaloes [Arunachalam *et al.*, 1952]. Studies on the dairy and the beef breed of cattle indicated that there was no effect of age of the cow on the gestation period [Ragab and Asker, 1951; Lambardt, 1951; Burris and Blum, 1952; Lazarus and Anantakrishnan, 1952]; but Jafar *et al.*, [1950] reported after studying gestation periods of 202 males and 102 females in Holstein Frisian cattle that the order of calving had a significant effect in the female calves but not in the males. Choudhry and Sinha [1951] observed that the gestation period appears to be slightly affected by the age of the cow at the time of calving. Jafar *et al.*, [1950], Burris and Blum [1952], Arunachalam *et al.*, [1952] found that the season of calving had no influence on the gestation period, whereas, Ragab and Askar [1951], Choudhry and Sinha [1951] and Brakel *et al.*, [1952] reported to the contrary. Ragab and Asker [1951], Brakel *et al.*, [1952], Wheat and Riggs, [1952] stated that the sire of the calf affects the duration of pregnancy but others [Burris and Blum, 1952; Arunachalam *et al.*, 1952] could not establish this fact. Coefficient of correlation between the length of gestation and the length of dry period were not statistically significant [Lambardt, 1951; Anantakrishnan, 1952]. The correlation between the cow's body weight and the gestation period was positive but not significant statistically [Anantakrishnan *et al.*, 1952].

Material and Methods

The data for the study were collected from a herd of Hariana cattle, a 'dual purpose' breed (milk and draught) belonging to a scheme, financed jointly by the Indian Council of Agricultural Research and the Punjab State during a period of eight years (1946 to 1953) on 797 parturitions. The foundation stock was built up of 230 Hariana females which included 150 heifers of nearly the same age and 80 cows of different ages. All the animals were so selected that they conformed to a certain standard of body conformation of the breed. Ten young bulls (with 4 in reserve) conforming to Hariana breed were selected with a similar criterion. With a view to have a sufficient variability in the stock, half of the number of these bulls was purchased from outside, while the others comprising other half was taken from the farm-bred stock. All the 230 cows and 10 bulls were randomized into ten groups.

The herd depended on natural grazing for a considerable part of the year. They were stall fed when grazing was scanty. In the case of milch stock, the grazing was supplemented by the concentrates according to milk yield. The cattle, generally, for the most part of the year remained in the open thorny enclosure except during severe winter nights.

Two vasectomised bulls were kept in the herd to detect the cows in heat and these were bred by their respective bulls. The gestation periods were calculated in days from the services resulting into calvings. All cases of abortions and still-births were excluded from this study. Doubtful cases were not taken into account.

Statistical analysis were made according to the disproportionate class method of Snedecor [1948] for studying the effects of season, sire and the sequence of calving on the length of gestation period.

Results

Length of the gestation periods

In order to determine the effect of sex on the length of gestation period, the data were grouped (Table I) with a class interval of 10 days. It was observed that largest percentage (44·28) of males was born between an interval of 290-299 and females (50·00) between 280-289 days after conception. The mean gestation period of males and females was $291{\cdot}78 \pm 0{\cdot}87$ and $289{\cdot}68 \pm 0{\cdot}94$ days respectively with an overall average of $290{\cdot}73 \pm 0{\cdot}91$ days (Table II).

TABLE I

Distribution of the length of gestation of Hariana cows

Gestation period (days)	Number of calves			Distribution of gestation period		
	Male	Female	Total	Male per cent	Female per cent	Total per cent
230—39	1	1	2	0·24	0·26	0·25
240—49	..	..	..	..	..	..
250—59	6	4	10	1·46	1·04	1·25
260—69	4	2	6	0·97	0·51	0·75
270—79	21	22	43	5·11	5·70	5·40
280—89	140	193	333	34·06	50·00	41·78
290—99	182	123	305	44·28	31·87	38·27
300—09	33	19	52	8·03	4·92	6·52
310—19	11	12	23	2·68	3·11	2·89
320—29	8	7	15	1·90	1·81	1·88
330—39	3	2	5	0·73	0·52	0·63
340 and above	2	1	3	0·49	0·26	0·38
TOTAL	411	386	797	100·00	100·00	100·00

TABLE II

Mean gestation periods for male and female calves

Male		Female		Total	
No. of cases	Mean (days)	No. of cases	Mean (days)	No. of cases	Mean (days)
411	291·78±0·87	386	289·68±0·94	797	290·73±0·91

Effect of sex and sequence of calving

To compare the effects of the order of calving and the sex of the calves on duration of gestation period, the means were calculated for each calving (Table III). The analysis of variance (Table IV) was carried out on 793 cases. Records of the last three lactations, being few, were excluded. It showed that the differences for sequence of calving and sex were significant.

The results are presented below in bar notation :

Lactation number	9	6	3	5	2	8	7	1	4	11	10
Average gestation period (days)	308·5	293·7	293·3	293.3	290·7	289·8	289·3	289·1	288·5	288·0	283·0

TABLE III

Influence of sex and sequence of calving

Lactation	Male		Female		Total	
	No. of cases	Mean	No. of cases	Mean	No. of cases	Mean
1st	117	290·1±1·7	120	288·1±1·5	237	289·1±1·3
2nd	97	291·2±1·2	74	289·9±1·7	171	290·7±1·1
3rd	68	293·0±2·3	70	293·5±1·9	138	293·3±1·6
4th	53	288·8±1·6	60	288·3±2·6	113	288·5±1·5
5th	46	295·5±1·6	32	289·2±0·6	78	293·3±0·5
6th	18	299·3±3·9	16	287·5±2·2	34	293·3±1·9
7th	6	290·8±1·3	8	288·1±1·5	14	289·3±1·0
8th	4	290·3±1·4	4	289·2±1·6	8	289·8±1·3
9th	2	308·5±4·9	..	..	2	308·5±4·9
10th	..	..	1	283·0±0·0	1	283·0±
11th	..	..	1	288·0±0·0	1	288·0±
TOTAL	411	..	386	..	797	..

TABLE IV

Analysis of variance of gestation periods for sex and calving sequence

Sources of variation	D.F.	Sum of sq.	Mean s.	F.
Between lactations	7	2930·5	418·6	2·46*
Between sexes	1	855·0	855·0	5·03*
Between sex and lactation interaction	7	1206·2	172·3	..
Within	777	132102·6	170·0	..
TOTAL	792	..	..	..

* Significant.

Effect of the month of calving

The mean gestation periods of calves born according to the month of calving (Table V) worked out to be the longest for males and females during the month of October. The number of calvings was more during the months of February, March and April, thereby indicating that majority of cows conceived at the end of spring or early summer. Analysis of variance (Table VI) showed that variations between months and the sex were significant.

The results are presented in bar notation were :—

Month	Oct.	Mar.	May	April	Jan.	Feb.	Aug.	Nov.	Sept.	July	June	Dec.
Average gestation period (days)	295·4	293·4	291·7	291·5	291·4	291·2	290·1	290·1	289·6	288·9	288·2	286·0

TABLE V

Influence of the month of freshening on gestation period

Months	Male		Female		Total	
	No. of cases	Mean	No. of cases	Mean	No. of cases	Mean
January	28	293·0±2·1	52	290·6±4·3	80	291·4±1·9
February	43	292·9±1·3	44	289·5±1·2	87	291·2±1·0
March	61	294·5±2·8	53	291·7±1·9	114	293·4±1·8
April	47	291·3±1·4	40	291·6±1·8	87	291·5±1·1
May	35	293·2±3·1	17	288·2±2·5	52	291·7±2·1
June	39	289·9±2·6	33	286·2±2·4	72	288·2±2·3
July	32	290·5±1·4	34	287·4±1·2	66	288·9±1·1
August	21	291·9±0·9	23	288·3±0·9	44	290·1±0·8
September	31	288·6±1·7	20	290·9±2·3	51	289·6±1·4
October	18	297·1±3·2	20	293·8±1·8	38	295·4±1·6
November	24	289·8±1·2	23	290·3±1·4	47	290·1±1·1
December	32	287·0±1·9	27	284·8±2·1	59	286·0±1·6
TOTAL	411		386		797	

TABLE VI

Analysis of variance of gestation period for month of calving

Source of variation	D.F.	Sum of sq.	Mean s.	F.
Between months	11	3863·3	351·1	2·04*
Between sex	1	921·3	921·3	5·36*
Between sex and month interaction	11	1155·8	105·1	0·6
Within	773	133642·2	172·8	..
TOTAL	796			

* Significant.

Effect of sire of the calf

The mean gestation period for calves as influenced by different sires (Table VII) varied from 277·8 to 294·3 days and the mean squares for sires were significant (Table VIII). Bull No. 210H2/46 was not included in the analysis, as it had only one case.

TABLE VII

Effect of sire of the calf on gestation period

Sire No.	Male		Female		Total	
	No. of cases	Mean	No. of cases	Mean	No. of cases	Mean
274H 2/39	10	278·2±0·8	9	276·2±0·8	19	277·8±0·6
2HP/44	52	291·7±0·9	48	290·6±0·8	100	291·3±0·7
3HP/44	58	292·6±2·0	36	288·8±1·5	94	291·2±1·4
13HP/44	33	290·8±1·9	57	285·4±1·6	90	288·6±1·3
15HP/44	30	294·3±2·7	35	290·2±1·2	65	292·1±1·1
163H1/40	36	296·8±2·9	31	287·3±2·3	67	292·4±2·1
18HP/46	14	292·5±1·5	17	295·4±1·3	31	294·3±1·1

TABLE VII (contd.)

Effect of sire of the calf on gestation period

Serial No.	Male		Female		Total	
	No. of cases	Mean	No. of cases	Mean	No. of cases	Mean
2HP/42	10	291·9±1·9	17	290·7±1·4	27	291·1±1·2
190H1/42	34	291·0±0·9	35	290·9±1·0	69	291·0±0·8
512H4/41	50	285·9±2·3	38	293·1±1·5	88	291·4±1·4
395H2/42	37	293·9±1·2	31	289·5±1·1	68	291·9±1·0
203H1/42	26	288·4±2·8	17	286·7±2·0	43	287·8±1·8
210H2/46	1	292·0±0·0	..	..	1	292·0±0·0
227H1/42	20	289·0±1·0	15	291·8±1·0	35	290·2±0·8
TOTAL	411		386		797	

TABLE VIII

Analysis of variance of gestation periods for sires

Source of variations	D.F.	Sum of sq.	Mean s.	F.
Between sires	12	4971·2	414·3	2·59†
Between sex	1	996·4	996·4	6·23*
Between sex and sire interaction	12	3104·9	258·7	
Within	770	121854·3	158·3	
TOTAL	795			

*Significant
†Highly significant

Influence of body weight and dry period on gestation

The body weights of majority of the cows were recorded within 24 hours after calving and the preceding gestation periods of these cows for different lactations were studied (Table IX). It was observed that in general with the increase in live-weight of the animal the gestation period prolonged.

The dry period for each animal in different lactations and its corresponding gestation period was also studied but it did not show any definite trend.

TABLE IX

Length of gestation period, body weight and dry period

Gestation period (days)	No. of cases	Av. body wt. (lb.)	No. of records	Average dry period (days)
230—39	..	..	2	310·0±20·7
240—49	..	..	..	..
250—59	7	703·1±12·3	3	169·0±7·4
260—69	5	674·4± 8·6	3	228·0±11·3
270—79	30	706·3± 6·3	27	278·7±14·5
280—89	253	707·2± 5·8	185	262·1±13·4
290—99	251	723·4±13·4	168	277·7±13·7
300—09	39	735·7±12·3	35	259·1±12·4
310—19	17	740·7± 9·5	15	290·3±15·0
320—29	14	747·4± 7·6	9	205·7±11·7
330—39	2	771·5±14·4	4	188·5± 8·7
340 and above	3	738·3± 4·6	4	366·0±17·3
TOTAL	621		455	
Weighted mean		717·4		267·9

Relationship of birth weight, dry period, body weight of the dam with gestation period

The correlation coefficient of gestation length and birth weight was low (0·13) but significant, between body weight and gestation period was also significant (0·14) while for dry period it was not significant.

Discussion

The results of these investigations revealed that Hariana cattle carried their calves for a mean period of 290·73 days, which was longer than that for European and Indian cattle except the Tharparkar cows which carried their calves for 290 days [Kumaran, 1947] which was almost the same as observed in this study. This indicated that the dual purpose breed carried their calves longer than dairy breeds.

The sex of the calf was responsible for variation in the length of gestation period. Significant difference of two days was found between gestation periods for males and females which showed that the sex of the calf had an effect on it. This was in agreement with the observations of other workers [Jafar *et al.*, 1950 ; Choudhry and Sinha, 1951 ; Jordao *et al.*, 1951 ; Lazarus and Anantakrishnan, 1952].

Sequence of calving and the sex was observed to have a significant effect on the gestation period whereas Choudhry and Sinha [1951] observed that the age of the cow slightly affected the gestation period.

The month of freshening was found to have influence on duration of pregnancy and this result agreed with the observations made by Ragab and Asker [1951], Choudhry and Sinha [1951] and Brakel *et al.*, [1952].

The paternal influence in the gestation period was found to be statistically significant and this confirmed the findings of Ragab and Asker [1951], Brakel *et al.*, [1952], Wheat and Riggs [1952].

The positive correlation between the birth weight of the calf and duration of pregnancy was in agreement with the findings of Jafar *et al.*, [1950], Ragab and Asker [1951], Jordao *et al.*,[1951], Brakel *et al.*, [1952] and Arunachalam *et al.*,[1952]. The body weight of the dams at the time of calving had also significant correlation with the gestation period. From that it could be postulated that the retention in the herd of animals with heavy body weights could increase the gestation period.

Summary

1. The average length of 797 gestation periods in Hariana cattle was 290·7 ± 0·9 days. Male calves were carried to a significantly longer period of time than females.

2. The sequence of calving, month of freshening, sire and sex had a significant effect on gestation period.

3. There were positive correlations between the body weight of the dams and the birth weight of the calf with the gestation period. No significant correlation was observed between the dry period of the cows and the gestation period.

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FACTORS AFFECTING BIRTH WEIGHT IN HARIANA CATTLE

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(Received for publication on July 30, 1956)

THE study of the birth weight of the calves is of great importance to a breeder, for judging their general health and prospective growth. Different workers investigated the effect of several factors on the birth weight of the calves. Arunachalam *et al.*, [1952] stated that the sex of the calf had no influence on the birth weight in Murrah buffaloes while Choudhuri and Sinha [1951] and Anantakrishnan and Lazarus [1953] found that the bull calves were carried heavier than the heifer calves in Tharparkar, Red Sindhi, Gir and cross-bred calves. A definite relationship existed between the age of dam and birth weight of calves as observed by Burris and Blum [1952] in beef cattle, Arunachalam *et al.*, [1952] in Murrah buffaloe and Anantakrishnan and Lazarus [1953] in Indian dairy cattle but Jordao [1951] reported contrary in Brazil dairy cattle. No effect of season was observed in buffaloe [Arunachalam *et al.*, 1952] and in cattle [Burris and Blum, 1952 and Anantakrishnan and Lazarus, 1953]. Arunachalam *et al.* [1952] and Anantakrishnan and Lazarus, [1953] stated that the sire of the calf affected the birth weight but Burris and Blum [1952] could not establish this fact.

Material and Methods

The data used in the study were taken from Hariana herd of cattle, bred and raised at the Government Livestock Farm, Hissar (Punjab), from 1946 to 1953. In all 771 birth weights of calves were studied. The calves were dropped at all seasons of the year and were weighed within 24 hours after birth.

The methods used for the study of analysis of variance were those described by Snedecor [1948] for the disproportionate class.

Results

Effect of sex and sequence of calving

The average birth weight of 771 calves was 50·8 lb., for 402 male calves the average was 51·8 lb. and for 369 females 49·8 lb. The smallest calf weighed 28 lb. while the largest weighed 80 lb. at birth.

The birth weight of the calves in different lactations was studied (Table I). It did not indicate any definite pattern with the increase in number of lactation.

The analysis of variance was carried out on 767 cases (Table II). Records of the last three lactations, being few, were excluded. It showed that the calving sequence had no significant effect on birth weight. The birth weight of the calves, however, varied significantly between sexes, male calves had higher birth weight than female calves.

TABLE I

Influence of calving sequence of the dam on birth weight of the calves

Lactation No.	Male		Female		Total	
	No. of cases	Mean	No. of cases	Mean	No. of cases	Mean
1st	116	50·9±0·9	122	48·8±0·8	238	49·8±0·6
2nd	99	51·9±0·8	70	50·9±0·8	169	51·5±0·6
3rd	67	53·2±1·4	64	50·2±0·7	131	51·7±0·8
4th	48	50·5±0·7	54	50·0±1·2	102	50·3±0·7
5th	43	51·9±0·8	32	48·7±1·2	75	50·6±0·8
6th	16	53·3±1·2	14	51·0±2·3	30	52·2±1·3
7th	7	53·1±4·3	8	52·0±2·1	15	52·5±2·3
8th	4	54·7±4·2	3	49·7±3·5	7	52·6±2·9
9th	2	53·0±1·4	..	..	2	53·0±1·4
10th	..	..	1	57·5±0·0	1	57·5±0·0
11th	..	..	1	60·0±0·0	1	60·0±0·0
Total	402	51·8	369	49·8	771	50·8

TABLE II

Analysis of variance of birth weight between calving sequence and sex for birth weights of calves

Sources of variation	D.F.	Sum of squares	Mean S.	F.
Between calving sequences	7	509·4	72·8	0·96
Between sex	1	773·7	773·7	4·21*
Between sex and calving sequences interaction	7	230·4	32·9	
Error	751	139073·6	185·2	
Total	766	..	..	..

*Significant.

Effect of month of calving

Variations in birth weight of calves were observed for different months of the year (Table III).

The influence of the month of freshening on the birth weight of calves was not found to be statistically significant (Table IV).

TABLE III

Influence of month of calving on birth weight

Month	Male		Female		Total	
	No. of cases	Mean	No. of cases	Mean	No. of cases	Mean
January	27	51·7±1·3	48	49·7±2·3	75	50·4±1·5
February	41	52·6±2·0	43	50·7±1·7	84	51·7±1·4
March	55	53·6±1·7	51	51·1±1·5	106	52·3±1·1
April	47	52·7±0·8	37	52·7±1·0	84	52·7±0·6
May	35	50·3±1·3	17	46·7±1·4	52	49·0±0·9
June	39	50·0±1·6	32	48·7±1·8	71	49·4±1·2
July	33	49·0±0·9	34	46·3±0·8	67	47·6±0·6
August	22	50·2±1·4	23	49·9±2·0	45	50·0±1·2
September	32	51·3±1·3	21	49·2±1·5	53	50·5±0·9
October	18	54·8±2·9	17	49·1±1·7	35	52·1±1·7
November	23	50·3±0·9	20	50·1±1·0	43	50·2±0·7
December	30	54·1±2·4	26	50·7±1·5	56	52·5±1·5
Total	402		369		771	

TABLE IV

Analysis of variance of birth weights between months and sex

Sources of variation	D.F.	Sum of squares	Mean S.	F.
Between months	11	1660·3	150·9	0·82
Between sex	1	815·5	815·5	4·47*
Between sex and months interaction	11	318·7	29·0	
Error	747	137933·3	184·6	
Total	770			

*Significant

Effect of sire of the calf

The average birth weight of calves, progeny of different bulls, varied from 47·8 to 59·0 lb. (Table V). Statistical analysis (Table VI) carried out on 770 cases revealed that the influence of the sire on birth weight was not significant. Bull No. 210H2/46 was not included in the analysis as it had only one case.

TABLE V

Influence of sire on birth weight of calves

Sire No.	Male		Female		Total	
	No. of cases	Mean	No. of cases	Mean	No. of cases	Mean
274H2/39	9	60·6±2·5	8	55·7±2·9	17	58·4±1·9
2HP/44	50	50·7±0·8	47	48·1±1·1	97	49·4±0·6
3HP/44	56	50·2±1·1	36	47·3±1·8	92	49·1±0·8
13HP/44	34	51·0±1·3	50	49·4±0·6	84	50·1±0·6

TABLE V (*contd.*)

Influence of sire on birth weight of calves

Sire No.	Male		Female		Total	
	No. of cases	Mean	No. of cases	Mean	No. of cases	Mean
15HP/44	30	53·7±1·0	35	49·5±1·4	65	51·5±0·9
163H1/40	38	53·5±1·3	31	50·3±0·8	69	51·9±0·8
18HP/46	13	51·6±1·8	14	50·2±1·9	27	51·0±1·3
24HP/42	12	50·6±1·9	15	48·7±2·5	27	49·6±1·6
190H1/42	32	52·7±1·2	35	50·4±1·1	67	51·6±0·8
512H4/41	45	51·7±1·7	38	52·4±1·9	83	52·1±1·3
395H2/42	36	52·7±1·4	29	50·7±0·9	65	51·7±0·9
203H1/42	25	48·4±1·7	17	46·8±2·5	42	47·8±1·4
210H2/46	1	59·0±0·0	..	..	1	59·0±0·0
227H1/42	21	52·1±1·3	14	52·0+1·2	35	52·1±0·9
Total	402		369		771	

TABLE VI

Analysis of variance of birth weight between sires

Sources of variation	D.F.	Sum of squares	Mean S.	F.
Between sires	12	3351·9	279·3	1·59
Between sex	1	711·1	711·1	40·7*
Between sire and sex interaction	12	335·1	27·9	
Error	744	131757·9	177·0	

*Significant

Discussion

The results in this study revealed that the sex of the calf influenced the birth weight and that the male calves, on an average, were heavier than the females which was in agreement with the observations of other workers [Choudhury and Sinha, 1951 ; Anantakrishnan and Lazarus, 1953].

The sequence of calving and the month of freshening did not affect significantly the birth weight of calves, the former disagreeing with, while the latter conforming to the findings of Burris and Blum [1952] and Arunachalam *et al.* [1952].

The sire of the calf was found to have no influence on birth weight of the calf and this result agreed with the observations of Burris and Blum [1952] whereas Arunachalam *et al.* [1952] and Anantakrishnan and Lazarus [1953] observed to the contrary.

Summary

Bull calves, on an average, were significantly heavier than females.

Calving sequence of the dam, the season of freshening and the sire had no significant effect on the birth weight of the calves.

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ABSTRACTS

The use of blood culture in the routine diagnosis of anthrax.
THOMPSON, P. D. (1955). *J. Comp. Path.* 65, pp. 1-7 (Tables. 5 Refs. 5)

THE author describes a blood-culture technique as an aid to diagnosis in cases of suspected anthrax in the field which could not be confirmed by microscopical examination of blood films and tried this technique along with guinea-pig and mouse inoculation for screening feeding stuffs and other material for the presence of *B. anibracis*.

He recommends that swabs from such cases may be put into a test tube to which is added 2 ml. of fresh defibrinated bovine blood and the tube incubated at 37°C. Positive results are obtained within about 3½ hours, but it is recommended that as a matter of routine the tube containing the swab and defibrinated blood should be incubated overnight, although six hours incubation gives quite satisfactory results. Before incubation, the swab is used to inoculate a guinea-pig. In positive cases, the smears made from the contents of the tube after incubation showed organisms with well-marked capsule formation.

Defibrinated blood of sheep and sera from cattle, horse, sheep, donkey and pig were also tried in a few cases with similar results. At the same time anthracoids were also used in a few trials, and these failed to exhibit any capsule formation.

For examining the feeding stuffs the author adopted the following technique: 15 gm. of the material for examination was mixed with 150 c.c. of N. S. S. in a flask and kept overnight in the refrigerator. After this the flask was heated to a temperature of 65°C for 5 minutes and then the contents were filtered through double layer of muslin cloth. The filtrate was spun for 10 minutes at 3000 r.p.m. The deposits so obtained were resuspended in N. S. S. and recentrifuged. The final deposit was mixed with 8 c.c. of N. S. S. and out of this material 1 ml. was inoculated into the blood, 1 ml. into one guinea-pig, 3 ml. into a second guinea-pig, and 0·2 to 0·5 ml. into each of six mice, all animal inoculations being done subcutaneously. Smears from the blood culture of the swab and from the site of inoculation, heart and spleen of the animals were examined and cultures were also attempted from the same organs.

The author concludes that the blood culture method has the advantage of being cheap, simple and apparently more sensitive than the method of guinea-pig inoculation.

In examining the feeding stuffs and other material the inoculation of six mice appeared to be superior to the inoculation of two guinea-pigs or one blood culture, but a combination of all three methods gave the best results. (S.L. 1.)

Evaluations of some new insecticides against lice on livestock and poultry. CHARLES L. SMITH and ROWLAND RICHARDS. *J. Econ. Ento.* **48.** (5) : 566-568

SPOT-TREATMENT tests and field trails with some of the new insecticides against lice of cattle, goats and poultry were conducted at Kerrvile, Texas, U.S.A., during 1953 and 1954. A number of chemicals tested against the short-nosed cattle louse *Haematopinus eurysternus* (Nitz.) gave good initial kills at concentrations of 0·25 per cent or above. The chlorinated hydrocarbons used, i.e. DDT, toxaphene and strobane remained effective, giving 100 per cent control, for 3-4 weeks. Phosphorus insecticides, such as parathion, malathion and diazinon, were effective even at concentrations lower than 0·25 per cent but lost their residual effectiveness earlier than the chlorinated hydrocarbons. In field trials on cattle lice, strobane (0·5 per cent) and heptachlor (0·05, 0·1 and 0·5 per cent) were tested as wettable powder against long-nosed cattle louse, *Linognathus vituli* (L.). One hundred per cent control was obtained with both the materials up to 4 weeks after treatment.

DDT, strobane, endrin, isodrin, malathion, diazinon, chlorthion, Bayer L 13/59, Bayer 21/199 and EPN treatments in evaluation tests against goat lice, *Bovicola caprae* (Gurlt.) and *B. limbatus* (Gerv.), by dipping method at different concentrations, gave 100 per cent kill in 24 and 48 hours, and most of them remained effective for 4 weeks. EPN (0·03 per cent), malathion (0·5 per cent), strobane (0·5 per cent), and heptachlor (0·25 per cent) used as spray against goat lice in field trials gave complete control within 24 hours. No louse was seen on the flock treated with strobane for 6 months after treatment. In other cases there were moderate to light infestations during the same period.

DDT, toxaphene, strobane, chlordane, methoxychlor, TDE (each 5 per cent) lindane, malathion and diazinon (each 1 per cent) were tested as dusts against the chicken body louse, *Eomenacanthus stramineus* (Nitz.). All the materials gave complete control of the original infestation and most of them showed residual effect till 4 weeks after treatment. (R.P.C.)

Rectal temperature and respiratory responses of Jersey and Sindhi-Jersey (F_1) crossbred females to a standard hot atmosphere. MCDOWELL, R.E., D.H.K. LEE, M. H. FOHRMAN, J. F. SYKES and R. A. ANDERSON (1955). *J. Dairy Sci.* **38 : 9 :** 1037-45

YOUNG heifers, old heifers, dry cows and lactating cows of Jersey breed and Red Sindhi-Jersey (F_1) crosses were exposed at regular intervals to a standard test atmosphere of 105°F with a vapour pressure of 34 mm. Hg. (wet bulb 92°F), and their rectal temperature and respiratory responses were observed. The mean temperature response of Jerseys was higher than that of crossbreds in all the groups and the difference was also observed in the cows of the two breeds with the same level of milk production. The initial rectal temperature, as also the subsequent rise, were higher in heifers, but the rise was similar in all ages. Dry cows behaved

very much the same as old heifers. The level of milk production had considerable effect in increasing the temperature response up to certain limits but not so the stage of lactation. A marked seasonal variation in temperature response was observed.

Jersey heifers exhibited a higher respiratory response to heat than crossbreds, but the reverse was true for lactating cows, and no difference was seen in dry cows. The author concluded that differences in respiratory rate are the results and not the cause of differences in heat tolerance. (S.G.)

Urea as a protein extender for lactating cows. G. M. WARD, C. F. HUFFMAN, and C. W. DUNCAN (*1955*). *J. Dairy Sci.* **38**, 298

TEN cows (nine Holstein and one Guernsey) were used to compare the effect on milk production of a urea and corn supplement with that of a soybean oil meal supplement. Each experimental period of nine days was preceded by 12 days preliminary period, during which the animals were fed on a low-protein ration; the animals were then assigned to four groups : two groups of two and two groups of three cows each. The low-protein roughage consisted of chopped seed-stage-timothy hay, molasses and ground corn. The concentrate mixture was fed either by intimately mixing in the roughage or by placing it on top of it. A Latin square design was used. The average daily milk production for each 9-day period was determined as fat-corrected milk based on 3-day composite butter-fat tests.

During the initial protein-depletion period of 12 days the F.C.M. was reduced by about 20 per cent, but the milk production levelled off after 6 days. The loss in body weight suffered by the animals during the period was on an average 55 lb., after which it remained constant.

The intake of total digestible nutrient and digestible crude protein by the animals were calculated on the basis of actual ingestion of feeds, assuming the digestibility coefficients.

No significant difference in the body weight or milk yield of the animals was produced by the feeding of urea or soybean oil meal or by the difference in the method of feeding this supplement. (K.S.)

The effect on conception rates of semen diluents containing citrate or phosphate buffer, with all combinations of sulphanilamide, streptomycin and penicillin. R. C. CAMPBELL and J. EDWARDS (1955). *J. Agric. Sci.* **46**, Part I, pp. 44-45

BACTERIA in semen used for artificial insemination reduced the fertilizing capacity of the semen. Many experiments have been carried out to show that conception rate can be increased by the use of semen supplements, e.g. sulphonamides, penicillin, streptomycin, aureomycin, etc. In the present investigation, attempt has been

made to find out the effects of adding sulphanilamide, streptomycin and penicillin (in various combinations) to semen diluents, and to determine the conception rates obtained when citrate or phosphate buffer was used to dilute the semen. The amounts of sulphanilamide and antibiotics added to 1 ml. of diluted semen were :

Sulphanilamide . . . . 1·5 mg.

Streptomycin (calcium chloride complex) . 500 ,,

Penicillin (sodium G) . . . . 500 units.

The experiment involved 68,713 first inseminations carried out at four centres in U. K. It was found that unsupplemented phosphate buffer gave a conception rate 5·5 per cent above that which was obtained with unsupplemented citrate buffer. Phosphate buffer depressed conception rate when used with sulphanilamide or streptomycin. With penicillin, the phosphate buffer gave 9·3 per cent higher conception rate than that obtained with unsupplemented citrate buffer. Citrate buffer with sulphanilamide, streptomycin and penicillin gave a conception rate 6·8 per cent above that obtained with unsupplemented citrate buffer. (S.N.L.)

REVIEW

A HAND BOOK OF ANIMAL HUSBANDRY AND DAIRYING

By

V. T. Subbiah Mudaliar

(Published by the Bangalore Printing and Publishing Co., Ltd., Post Box No. 507, Mysore Road, Bangalore-2—1956, pages 228. Price 8/12/-)

THIS is one of the three books written by the author, 'Common Cultivated Crops of South India', 'A Hand book of Animal Husbandry and Dairying and 'The Principles of Agronomy ' (under print). These books have particularly been written for the students and cover the syllabus prescribed by the Universities in South India.

The Hand book on Animal Husbandry and Dairying is divided into two parts : The first part (110 pages) deals with the breeds of India, methods and principles of breeding, judging, feeding, feeds, management of cattle and other farm livestock. The second part (100 pages) covers chemistry, bacteriology and technology of milk and milk products. It is felt that the treatment of the subjects covered is quite adequate for undergraduates but the graduates must also consult other books on each aspect.

The book is intended for South India as it refers to conditions in the South. Thus, breeds of cattle in the South have been described well and North Indian breeds have only been described if they are of any importance to the South. Conditions of farming in the South have been given and recommendations made to suit those conditions.

The book has been written in a clear and easy style. It is well printed and has a pleasing get up.

MGIPC—M—56 AR/56—9-4-57—1,000.

STUDIES ON INDIGENOUS CREEPERS

A NEW RAIN-FED, HIGH PROTEIN PHOSPHORUS-RICH PLANT

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IT is now generally agreed that an acute shortage of protein-rich feeds in the dietary is primarily responsible for the poor condition of our cattle. It has been estimated [*Human nutrition vis-a-vis animal nutrition in India*, 1953] that the country as a whole is short of protein-rich concentrates at least to the extent of about 75 per cent.

Attempts have been made in the past [Dasgupta, 1943] to replace concentrates from the ration of milch and growing animals with leguminous roughages. The results of these investigations tend to show that when 75 per cent of the concentrates is replaced by legume hays, animals grow at a much slower rate than those receiving a full quota of concentrates.

Now it appears most convincing [*N. R. C. report on dairy cattle*, 1950] that during early growth an exclusive feeding of low phosphorus/high calcium legume or the incorporation in the diet a large proportion of it creates conditions that are at least not very favourable for such animals to record their full size as dictated by heredity. It is obvious that 7-8 lb. of green legumes like berseem (*Trifolium alexandrinum*) or similar feeds will be needed to supply one gram of phosphorus (P). To provide, therefore, enough of this element during the active period of growth, it may be necessary to feed about 80-100 lb. of these feeds, which obviously is beyond the capacity of such young calves to consume.

Furthermore, an abnormally wide calcium to phosphorus ratio as 10 : 1, normally found in most of these legumes, specially when raised in highly alkaline soils rich in calcium, appears to be another limiting factor.

In a preliminary study, it has been observed that when all concentrates are replaced by green legume or its equivalent hay and the whole ration made otherwise adequate for growth by introducing sufficient phosphorus deficient straws, growth is severely restricted and maturity very much delayed in cattle. While the control animals on a diet of concentrates, straws and a little green (5 lb.) registered their usual height and showed oestrus at the age of about 26 months; identical animals under legume and straw feeding, even at a higher plane of protein nutrition failed to show any sign of oestrus at the age of four years in seven out of eight instances. They also looked very much smaller than those fed with concentrates. The content

of copper in the blood of all these animals, however, showed normal values. Similarly, on a ration of this kind, although the milk yield during the entire lactation was not much affected, but in the majority of the cases, the animals failed to come into heat and appeared to have suffered from a sort of nutritional sterility [Talapatra, 1955].

Information on the chemical composition and nutritive value of the indigenous or cultivated fodder plants so far available [Sen, 1937 ; Kehar, 1947 ; Talapatra 1949, 50] indicates that they may be poor in protein, calcium and phosphorus or in any two or one of these indispensable nutrients. An all-round fodder plant rich in protein, calcium and phosphorus for the purpose of growth and milk production is yet to be found. For the past several years we were searching for a number of indigenous fodder plants which should not only be rich in protein, calcium and phosphorus but should grow without irrigation during monsoon and be available for conservation in late October when weather conditions are, in general, most favourable for hay making in any part of the country.

In this article an attempt has been made to present the chemical properties and nutritive value of one such indigenous plant which not only grows in desert-like conditions but appears to supply enough nutrients for growth, milk and wool production.

Ipomoea pestigridis known locally as '*Ghiyabati*' is a creeper like kudzu vines which grows aggressively in a wild state during the monsoon in the western tract of Uttar Pradesh and probably in other parts of the country. It is considered as a sort of weed in *jowar* fields and when cultivated can be successfully raised along with *jowar*. When grown singly, it produces a thick dense mass and abundant foliage for about three to four months and remains green and succulent even in late October when other green feeds are almost entirely absent in this part. Its immature seeds look like English peas, while the mature ones are black and resemble more or less sann-hemp seeds. Normally it appears to give two cuttings, but the yield in the second cut is comparatively much smaller than the first cut.

I. Chemical Composition and Palatibility

The chemical composition of the new feed on dry matter basis under a variety of conditions is shown in Table I, while the detailed analysis has been shown at other relevant places.

In mid-August when a large supply is available for feeding cattle, the protein content of the plant on dry matter is about 21 per cent ; with progressive maturity it is lowered by almost half. It appears from the data shown above that even in late October it contains as much protein as can be found in some of the legumes at their later stage of growth. The data shown in column 3 indicate that for a period of about 45 days from 8th September to 22nd October, the plant showed a fairly constant level of protein with an average of about 13 per cent, regardless of the locality from which samples were collected for analysis. A leaf meal prepared out of the plant in September showed 19 per cent protein, while the second cut sample (shown in the last column) 17 per cent. As expected both the mature and immature seeds were fairly high in protein, viz. about 30 and 22 per cent respectively.

TABLE I

The chemical composition of the creeper

Nurtients	Chemical composition of the plant with progressive maturity under controlled conditions in experimenta plots			Chemical composition of the plant growing in a wild state collected at random from different localities between 8th September and 22nd October 1955					Distribution of nutrients in leaf meal and stem on 25th Sept. 1955 from a plot manured with cow dung		Composition of immature and mature seed		Composition of the plant when new growth allowed after the first cut under controlled conditions in experimental plots
	First cut 17-8-55	Second cut 25-9-55	Third cut 22-10-55	Sample No. 1 8-9-55	Sample No. 2 25-9-55	Sample No. 3 29-9-55	Sample No. 4 1-10-55	Sample No. 5 22-10-55	Leaf meal	Stem	Immature seed	Mature seed	28-9-55
Crude protein	20·7	13·7	12·1	12·3	13·7	11·2	13·0	12·1	19·0	5·2	21·69	30·19	17·6
Calcium	1·32	0·90	0·92	0·91	0·90	1·06	1·00	0·95	1·44	0·86	0·21	0·38	1·00
Phosphorus	0·32	0·37	0·43	0·48	0·37	0·42	0·45	0·43	0·55	0·65	0·70	1·03	0·43
Oil or other extract	..	..	..	3·00	..	3·50	..	..	..	..	9·90	11·10	..

The important point which goes to make this plant be valuable is that unlike the legumes it is also rich in phosphorus with an ideal calcium to phosphorus ratio. The average content of phosphorus in berseem or similar feeds grown on alkaline soils, where they seem to thrive best, is about 0·2 per cent on dry matter, while under less favourable conditions this plant provides very nearly 2 to 2½ times more of this element than most of the protein-rich roughages (about 1 per cent P_2O_5). This ability of the plant to utilise phosphorus from a desert-like soil, highly alkaline and saline is definitely in favour of its introduction in Indian agriculture.

It may be seen from the data given in Table I that most of the samples can very easily be compared with some grains and other concentrates in its content of phosphorus. During the early growth when seeds are not formed, the phosphorus content of the plant is slightly lower, because both the immature and mature seeds are high in this element. It is definitely rich in calcium (about 1 per cent) and shows almost a uniform level of this mineral during its entire life cycle. The percentage of oil (about 10 per cent) present in the mature and immature seeds has been shown in column 5, while the same figure (about 3·5 per cent) for the plant itself in column 3.

It has been estimated that 50 per cent of the whole plant (on dry matter) consists only of high protein leaves. A few estimations of the amide nitrogen are shown below :

TABLE IA

The amide content of the plant

	1st cut sample in mid August (on dry matter)	Last cut sample in October (on dry matter)
Total N per cent	3·31	1·79
Albuminoid N per cent	2·83	1·63
Amide N per cent	0·48	0·16
Amide N as per cent of total N	14·5	8·9

Woodman [*loc. cit.*] has recorded in various green feeds such as barley, oats and pasture grasses amide N as 11 to 15 per cent of the total N. Although amide N, according to the same author may constitute as much as 60 per cent of the total N in some root crops, in this particular instance the author's findings, as shown in Table IA, are in agreement with those obtained by Woodman in British pastures and other green feeds. It may be mentioned here that on an exclusive feeding of succulent green feeds, the digestible crude protein of the feed cannot possibly be relied upon as a safe guide, because of the fact that the conversion of non-protein nitrogenous compounds into protein bodies by microbial activity is extremely slow and is largely conditioned by the presence or absence of refractory carbohydrates in the diet. As is well known, the usual British practice here is to use what is termed as "protein equivalent". Thus the requirement of green feeds for growth, milk production and similar body functions should be considerably more than is normally recommended in this country. From this standpoint the low content of amides

in any green feed should, in general, be preferred to those high in amides. It is obvious from the data shown in Table IA that the content of amide N is definitely lower than usually found in most of the protein-rich feeding stuffs. It may further be seen that as usual the content of the amide decreased with maturity.

The palatability of the new feed as measured by dry matter consumption per 100 lb. body weight with different species and categories of farm animals is shown in Table II. The average body-weight of the experimental animals was 830, 800, 1,000, 450 and 86 lb. respectively for bullocks, milch cows, milch buffaloes bull calves and sheep.

TABLE II

Dry matter consumption by different species and categories of farm animals

	Bullocks (sample fed at 16 per cent D.M. in September) (lb.)	Milch cows (sample fed at 20 per cent D.M. in October) (lb.)	Milch buffaloes (sample fed at 20 per cent D.M. in October) (lb.)	Bull calves (sample fed at 16 per cent D.M. in September) (lb.)	Sheep (sample fed at 16 per cent D. M. in September) (lb.)
	2·3	1·8	2·1	2·0	2·3
	2·0	1·8	2·2	1·9	2·7
	2·0	1·9	2·2	2·0	2·7
	..	..	..	1·9	2·3
Average	2·1	1·8	2·2	2·0	2·5

The average dry matter consumption by different farm animals may be considered very satisfactory. In the case of milch cows, the consumption is slightly less, because the sample fed to these animals was of a poor quality, mostly collected from *jowar* fields after the harvesting of the crop. It may be seen from the above data that at the comparatively early stage in September the bullocks consumed over 100 lb.; while the calves and sheep about 56 and 13 lb. respectively of the green feed. During the course of these investigations, it was also noticed that 16 months old calves could easily clear up about 25 lb. of the green feed in less than 3 hours time.

II. Evaluation of the Feed as a Green Fodder

For the purpose of evaluation, two species namely, adult bullocks and sheep were taken as experimental subjects. After the usual preliminary feeding period urine and faeces were collected by the technique followed at the Animal Nutrition

Division of the Indian Veterinary Research Institute at Izatnagar. The chemical composition of the green feeds on dry matter basis fed to two groups of experimental animals is shown below :

	Sample fed to sheep	Sample fed to bullocks
Crude protein	12·27	11·15
Ether extract	3·00	3·50
Ash	10·29	10·23
Crude fibre	26·23	26·18
Nitrogen-free extract	48·21	48·94
Calcium	0·917	1·060
Phosphorus	0·479	0·422

Both the samples may be considered identical in chemical make-up. In the sample fed to sheep, both mature and immature seeds were found in the pods, which they specially picked up and relished. The trial with bullocks was conducted after the experiment with sheep was over, hence more mature seeds were found in the pods. Compared to most of the indigenous and cultivated fodder grasses, it appeared to be low in fibre and rich in two of the most vital mineral elements. In Table III are shown the digestibility co-efficients of the various nutrients.

Both the species digested food nutrients almost equally well except the crude protein and nitrogen-free extract. Although the sample fed to sheep contained about 10 per cent more of protein than the one fed to bullocks, even then 11 per cent increase in protein digestibility in sheep of an apparently identical sample of feed was considered to be a bit too high. During the course of our metabolism experiments, it was observed that the hard seeds containing over 30 per cent of protein were not properly masticated by the bullocks, some of which were excreted in the faeces practically un-altered, while no such materials were found in the faeces of sheep. Thus the sheep utilised the seeds of the plant better than the bullocks. It may be mentioned here that in most of the Cambridge trials [Woodman, 1948] sheep were used as experimental subjects. Obviously under certain conditions of feeding such a procedure may slightly overestimate the value of the feed specially with regard to proteins and probably nitrogen-free extract, as the seeds in general are high in these nutrients. For this reason, the digestibility of ether extract should have been more in the case of sheep, because the seeds are also rich in oil. It may be seen from the results of chemical analysis given above that the sample fed to bullocks contained about 17 per cent more of the ether extract than the one fed to sheep and thus there was a sort of compensatory effect.

TABLE III

Digestibility coefficients of the feed

Particulars	Animal number	Dry matter	Crude protein	Ether extract	Crude fibre	N-free extract	Total carbohydrates
Sheep	1	68·0	73·6	61·6	52·7	80·0	70·6
	2	66·0	71·7	57·5	51·0	77·8	68·4
	3	68·0	72·7	57·0	53·0	79·2	71·4
	4	65·0	71·6	57·8	50·0	76·3	67·2
	Average	*66·8*	*72·4*	*58·5*	*51·7*	*78·3*	*69·4*
Bullocks	1	60·0	63·0	60·0	50·0	71·2	64·0
	2	63·0	66·6	62·1	52·2	74·0	66·5
	3	59·0	65·7	55·0	49·0	72·0	63·2
	Average	*60·7*	*65·1*	*59·0*	*50·4*	*72·4*	*64·6*

The balance of nitrogen, calcium and phosphorus has been shown in Table IV. The heavy retention of nitrogen in the case of bullocks is purely of a temporary nature, which is usually to be found when adult animals are kept on a high plane of protein nutrition [Talapatra, *loc. cit.*]

TABLE IV

The balance of nitrogen, calcium and phosphorus

Particulars	Animal number	Intake (gm.)	Excretion (gm.)			(gm.)
			Faeces	Urine	Total	
			Nitrogen			
Sheep	1	17·4	4·6	8·0	12·6	+4·8
	2	20·0	5·7	10·0	15·7	+4·3
	3	21·3	5·8	11·1	16·9	+4·4
	4	17·2	4·9	9·2	14·1	+3·1
			Calcium			
	1	8·12	6·66	0·45	7·11	+1·01
	2	9·35	8·45	0·52	8·97	+0·38
	3	10·00	8·74	0·60	9·34	+0·66
	4	8·03	7·50	0·30	7·80	+0·23
			Phosphorus			
	1	4·24	3·85	0·02	3·87	+0·37
	2	4·89	4·19	0·02	4·21	+0·68
	3	5·22	4·38	0·01	4·39	+0·83
	4	4·20	4·12	0·03	4·15	+0·05

TABLE IV—(contd).

The balance of nitrogen, calcium and phosphorus

Particulars	Animal number	Intake (gm.)	Excretion (gm.)			Balance (gm.)
			Faeces	Urine	Total	
			Nitrogen			
Bullocks	1	145·9	54·3	70·4	124·7	+21·2
	2	141·8	47·5	66·5	114·0	+27·8
	3	137·7	47·3	81·3	128·6	+9·1
			Calcium			
	1	86·71	81·24	0·90	82·14	+4·57
	2	84·27	80·27	1·67	81·94	+2·33
	3	81·83	80·09	0·60	80·69	+1·14
			Phosphorus			
	1	34·52	31·26	0·08	31·34	+3·18
	2	33·55	26·08	0·10	26·18	+7·37
	3	32·58	29·20	0·09	29·29	+3·29

III. EVALUATION OF THE FEED AS A HAY

From a perusal of the data given in Table I, it appears that it is an ideal fodder for conservation in the form of hay. Towards the end of October when weather conditions are favourable for hay making in this part, it contains on dry matter about 13 per cent of protein, 1·0 per cent calcium (1·4 per cent CaO) and 0·45 per cent phosphorus (1·04 per cent P_2O_5).

Sufficient quantity of the green fodder at 20 per cent dry matter, growing in a wild state round about the place, was collected during the early part of October and spread in the sun at 12 P.M.; at 2 P.M. a turn was given and the fodder allowed to dry in clear sunshine till 4 P.M. At this stage the dry matter of the plant rose from 20 to 32 per cent. The entire lot was then transferred and heaped loosely over a structure in a conical shape under a shed. It may be mentioned here that investigations on hay making in Assam [Talapatra, 1950] have shown that the dry matter

of the grass should be raised to at least 55 to 60 per cent before it could be safely stored over a tripod, but in this particular instance the dry matter of the plant at the time of storage was only about 32 per cent, as it was considered that in a dry climate it should be possible to prepare good quality hay by this method. Compared to 80 inches rainfall in Assam, the average in this part is only about 15 inches. Because of this low humidity, it was expected that even a simple procedure like the one described above should give satisfactory results and retain sufficient green colour in the hay so as to supply enough of carotene during the scarcity period.

Contrary to expectation, shortly after the transfer of the fodder to the shed, the weather turned unusually bad and then there was a heavy and widespread rainfall for the next three days. Thus the weather turned highly humid at least for a few days. From the climatological data, it appears, that this kind of weather was never been experienced in this part during the last 10 years. However, in spite of adverse weather conditions, the fodder dried up to 80 per cent dry matter in about 8 days time and retained considerable green colour even after 4 months of storage. The creeper when loosely packed and piled up in the form of a cone, allows sufficient aeration for quick drying. The hay thus prepared, (as will be shown later) was very much relished by both sheep and cattle; whereas the same plant when turned into hay in the open by the usual method was not at all relished by the sheep, though the bull calves consumed about 7 lb. of the withered stuff. It will be of considerable interest to know the extent the nutritive value of the hay affected when a green fodder is stored at 32 per cent dry matter. It may be mentioned here that the low humidity and dry climate of the region are, in general, favourable for green hay-making and it should be possible, with little modifications in the procedure, to prepare in these or similar areas hay which should be comparable with artificially dried grass. It is well-known that the high cost of drying the grass in machine definitely goes against its adoption in this country.

For the purpose of evaluation four adult rams weighing on an average about 89 lb. were taken. After the usual preliminary feeding period, urine and faeces were collected by the technique previously described. The feed consumption, chemical composition, the digestibility coefficients and the balance of nitrogen, calcium and phosphorus are shown in Tables V, VI, VII and VIII.

TABLE V

Palatability of the hay as measured by dry matter consumption

Animal number	Body weight (lb.)	Dry matter consumed (lb.)	Dry matter consumed per 100 lb. body weight (lb.)	Average consumption (lb.)
1	83	2·4	2·9	
2	89	2·3	2·6	
3	90	2·6	2·9	2·82
4	94	2·7	2·9	

TABLE VI

Chemical composition of the hay on dry matter basis (per cent)

Crude protein	13·58
Ether extract	3·50
Ash	11·88
Crude fibre	27·02
N-free extract	44·02
Total carbohydrates	71·04
Calcium	1·480
Phosphorus	0·344

TABLE VII

The digestibility coefficients of the ha

Animal number	Dry matter	Crude protein	Ether extract	Crude fibre	N-free extract	Total carbohydrates
1	54	57·1	69·7	45·8	59·8	54·5
2	50	57·4	67·5	40·0	56·0	50·2
3	48	54·0	67·4	41·0	53·2	48·7
4	51	60·0	67·0	40·0	59·1	51·0
Average	51	57·1	67·9	41·7	57·0	51·1

TABLE VIII

The balance of nitrogen, calcium and phosphorus

Animal No.	Intake (gm.)	Excretion			Balance (gm.)
		Faeces (gm).	Urine (gm.)	Total (gm.)	
		Nitrogen			
1	24·0	10·3	11·9	22·2	+1·8
2	23·5	10·0	13·3	23·4	+0·2
3	25·6	11·9	13·2	25·1	+0·5
4	26·6	10·7	14·1	24·8	+1·8
		Calcium			
1	16·23	13·50	0·11	13·61	+2·62
2	15·91	13·64	0·09	13·73	+2·18
3	17·45	15·80	0·10	15·90	+1·55
4	18·20	14·93	0·09	15·02	+3·18
		Phosphorus			
1	3·92	3·42	0·01	3·43	+0·49
2	3·85	3·80	0·01	3·81	+0·04
3	4·17	4·10	0·02	4·12	+0·05
4	4·31	3·75	0·02	3·77	+0·54

From the perusal of the data set forth in Tables V, VI, VII and VIII it appears that the consumption of the hay by the sheep was very satisfactory. The percentage of phosphorus in the hay was slightly lower than previously observed. This was due to the fact that during the course of transfer of the hay to the metabolism shed and chaffing, there was some loss of seeds.

It may be seen from the data given in Table VII that the crude protein digestibility of the hay was affected and lowered by about 20 per cent. The crude protein digestibility of the green feed by the sheep was about 72 per cent, as had been observed earlier, while the same figure was now about 57 per cent. Obviously, the three-day continuous rainfall at the time of storage and the subsequent high humidity developed during this period was responsible for this loss in digestible protein. Even then, it may be mentioned here [Talapatra, *loc. cit.*] that such results are only obtained in the humid areas under a very specialised condition, viz. when the dry matter of the plant is raised to about 60 per cent, that too in good weather and over frames. In fact, in humid areas, even in good weather, when green fodder was stored over frames at 30 per cent dry matter the entire hay was found to be decomposed. [Talapatra, unpublished work.] The digestibility of the ether extract had gone high from 60 per cent in the green fodder to about 68 per cent in the hay. This might be due to the fact that the fully mature seeds in late October contained over 10 per cent of oil. The digestibility of the crude fibre had also been lowered by about 20 per cent, that is, from about 50 per cent in the green feed to about 40 per cent in the hay. Apparently, the plant is considerably lignified towards the end of October when the hay was made.

The balance of nitrogen, calcium and phosphorus has been shown in Table VIII. The data are self-explanatory.

IV. Some Practical Considerations

From the average digestibility coefficients shown in previous Tables, the digestible crude protein, starch equivalent and total digestible nutrients of the green fodder and hay with two species namely, bullocks and sheep were calculated and are shown in Table IX.

Table IX

Digestible nutrients per 100 lb. of raw material

Name of the feed	Experimental subjects	Digestible crude protein (lb.)	Starch equivalent (lb.)	Total digestible nutrients (lb.)	Calcium (per lb. of the material) (gm.)	Phosphorus (per lb. of the material) (gm.)
Green *Ghiyabati* at 16 per cent dry matter	Sheep	1·43	8·9	10·3	0·65	0·33
	Bullocks	1·20	8·3	9·7		
Ghiyabati hay at 90 per cent dry matter	Sheep	7·0	30·0	45·0	3·7	1·8

From the data shown in the Table IX, it appears that 12 lb. of the green feed and 1 lb. of inferior quality hay or straw should suffice for 100 lb. ewes during the last 100 days of gestation as per N.R.C. standard, while in off season 2½ lb. of the hay and 1 lb. of straw should normally do for the same purpose.

One hundred pounds of the green feed and 5 lb. of straw should support a 15 pounder cow (800 lb.), while 20 lb. of the hay and 2½ lb. straw for an average 10 pounder cow.

Similarly, 50 lb. of the green feed and 1-2 lb. of straw, or 8-9 lb. of the hay in winter should be adequate during the active period of growth for dairy heifers.

It may be mentioned here that some authorities believe that straws should be removed from the ration of our animals. By a judicious combination with the proper type of feeds it should, perhaps, be possible to utilize these straws. It may be seen that in all these instances, it has been possible to avoid the introduction of costly concentrates in the ration for different categories of animals.

Summary

When all concentrates are replaced with high protein leguminous feeds and the whole ration made otherwise adequate by introducing sufficient phosphorus-deficient straws, it has been observed that the low phosphorus content of the 'all roughage ration' affects growth and reproduction in dairy animals.

It has been found that the indigenous creeper *Ipomoea pestigrides* is high in proteins and calcium like the legumes but unlike the latter is also rich in phosphorus. It is a rainfed fodder crop which grows profusely in August when it contains over 20 per cent of proteins on dry matter. In October and November when weather conditions are definitely favourable for hay making almost in every part of the country, it contains on an average about 12-13 per cent of proteins, 0·9 to 1·0 per cent of calcium and 0·4 to 0·45 per cent of phosphorus on dry matter.

Adult bullocks weighing a little over 800 lb. consume about 100 lb., while growing heifers and sheep 56 and 13 lb. respectively of the green feed, which contains on an average about 16 per cent of dry matter.

Of the 12-13 per cent proteins present in the creeper, bullocks digest about 65 per cent, while the sheep over 70 per cent, as the latter masticate the mature seeds (which contain over 30 per cent of proteins) of the plant more fully than the former.

Drying the plant in the sun for 4 hours and subsequent storing at 32 per cent dry matter out of contact with the ground over a structure lowers the protein digestibility by about 20 per cent. The hay thus made retains considerable green colour and is highly palatable to all species of livestock. On an average sheep consumed over 3 lb. of the stuff per 100 lb. body-weight.

The green feed contains about 1·5, 9·0 and 10·3 lb. of D.C.P., S. E. and T.D.N. respectively per 100 lb. of the material, while its hay 7·0, 30·0 and 45·0 lb. respectively of digestible crude proteins, starch equivalent and total digestible nutrients per 100 lb. of the air dry stuff.

It appears that an exclusive feeding of the plant either as a green fodder or as hay should provide enough nutrients including phosphorus for growth and average milk production.

When fed in very large quantities it tends to be slightly laxative but the desired consistency of the faeces is very easily obtained by introducing some straws in the dietary.

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CHEMICAL COMPOSITION OF CONCENTRATES

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THE major source of cattle-feed are (i) grass, (ii) specially grown fodder crops, (iii) straws of food grain, (iv) cottonseed and oilcakes and (v) by-products such as bran. However, food required for producing extra milk such as concentrates must be fed because (*a*) the maintenance requirement of cows and buffaloes and the present supply of milk is mainly derived from bulky unadulterated food, (*b*) milk production necessiates a high proportion of protein, (*c*) the milk is required for heavily populated areas and if it is to be delivered there in the fluid state, it must be produced in or near these areas ; such areas have few grazing facilities and for the most part, the milch animals and specially young stocks must be stall-fed.

All the animals housed in the Government Milk Colony Aarey are stall-fed and most of the feeds of the cattle are made up of concentrates. To understand how far the concentrates fed at the colony are nutritious and also as a step towards ultimately carrying out experiments for the study of the effect of different feeds on the quality of milk, a complete chemical analysis of all the concentrates, being used as feed at the Colony, was undertaken.

The results of analyses of cottonseed, *guar*, gram *chuni*, *tur chuni*, wheat bran, long *challa*, copra cake, groundnut cake and *til* cake are presented in this article.

Material and Methods

Collection of samples

Sample of each concentrate was selected at random from the stores of the Government Milk Colony, Aarey. Four such samples were collected at different times of the year.

Method of determination

All analyses were carried out by methods described in the *Hand Book of the A. O. A. C.* [1950] (1) in triplicate.

Results and Discussion

The results of analyses are presented in Table I. Table I shows that of all the concentrates groundnut cake contains the maximum protein with *til* cake coming next. *Guar*, *tur-chuni* and copra cake are also good sources of protein. Cottonseed, gram *chuni* and wheat bran are medium sources of protein, and long *challa* is a poor source of protein.

Table I

Percentage composition of concentrates on dry matter basis

Name of concentrate	Crude protein per cent			Ether extract per cent			Ash soluble in HCl per cent			P as P_2O_5 per cent			Ca as CaO per cent		
	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min	Average
Gowar	40·83	29·30	33·49	6·54	3·13	4·78	3·68	3·10	3·46	1·08	0·29	0·71	0·63	0·12	0·40
Gram *chuni*	22·29	16·18	19·12	5·04	3·89	4·53	3·59	1·41	2·83	1·09	0·22	0·65	0·89	0·74	0·81
Tur chuni	30·52	21·40	25·52	2·92	1·15	2·23	4·59	3·57	4·32	1·62	0·19	0·83	0·63	0·35	0·53
Wheat bran	18·96	14·57	16·83	4·56	4·53	4·54	5·71	3·34	4·72	3·15	2·64	2·96	0·37	0·27	0·31
Groundnut cake	55.12	47·78	51·82	8·71	6·29	7·55	4·48	3·62	4·07	1·66	0·50	0·92	0·36	0·24	0·31
Cotton seed	21·51	19·13	21·13	22·43	20·07	21·02	4·13	3·45	3·91	1·69	0·41	0·88	0·57	0·42	0·49
Til cake	45·68	35·67	41·48	15·82	4·90	10·72	10·76	8·80	9·91	2·66	0·73	1·76	3·96	2·53	3·24
Copra cake	24·70	21·85	23·18	16·85	4·81	12·10	5·17	4·49	4·87	1·20	0·50	0·89	0·24		
Long *challa*		8·57			0·58			2·78			0·37			066.	

Table II

Average percentage composition of concentrates obtained by different workers in different parts of country (dry matter basis)

Name	Place of origin	Total ash	Ash sol. in HCL	Ether extract Crude protein	Carbohydrates			Ca as CaO	P as P_2O_5	Reference
					Fiber	N2 free extract	Ca as CaO			
					Organic constituents					
Grains and seeds										
1. Cottonseed	Punjab	4·66	..	20·60	18·02	25·76	30·98	..	..	Sen (2)
2. Cottonseed Desi	Lyllapur	4·70	..	17·60	14·40	21·70	34·80	0·44	1·20	Lander (3)
3. Cottonseed 259 F Amm.	,,	4·00	..	18·80	18·10	26·20	25·60	0·34	1·25	,,
4. Cottonseed 43 F Amer.	,,	3·70	..	17·70	15·60	25·50	27·00	0·33	1·29	,,
5. Cottonseed 4 F	,,	4·60	..	20·70	17·50	21·50	29·50	0·40	1·30	,,
6. Cottonseed (undecosticated)	,,	6·00	..	8·50	21·10	22·30	34·60	0·25	1·20	,,
7. Cottonseed well pressed	..	4·40	..	6·30	28·50	23·80	31·70	..	..	Morrison (3)
8. Cottonseed	Bombay	5·09	3·46	21·00	21·10		52·81*	0·49	0·88	..
Oil cakes and M eals										
Ground nut cake	Bangalore	5·70	4·76	8·22	54·75	7·39	26·94	0·28	1·28	Sen (2)
Ground nut cake	Lyallpur	5·40	..	6·10	37·60	15·20	20·50	0·21	0·99	Lander (3)
Ground nut cake	Bangalore	5·30	..	7·70	48·70	6·90	25·4	0·25	1·19	,,
Ground nut cake	Bombay	6·02	4·07	7·55	51·82	34·61*	..	0·31	0·93	..
Oil Seeds and Cakes										
Til cake	Bangalore	11·02	6·85	9·91	46·30	4·92	28·85	..	..	Sen (2)
Til cake	Bombay	13·53	9·91	10·72	41·48	..	..	3·24	1·76	..
Copra cake Expeller	Cochin	8·34	6·48	8·20	25·34	13·20	44·92	0·56	1·69	Sen (2)
Copra cake (Country mill pressed)	,,	8·37	6·14	13·00	23·44	12·91	42·28	..	..	Sen (2)
Copra cake	Bombay	5·88	4·87	12·10	23·18	58·82*	..	0·19	0·89	..

*Carbohydrates by difference.

TABLE II—(contd.)

Average percentage composition of concentrates obtained by different workers in different parts of country (dry matter basis)

Name	Place of origin	Total ash	Ash sol in HCL	Ether extract	Crude protein	Carbohydrates		Ca as CaO	P as P_2O_5	Reference
						Fibre	N2 free extract			
By-products :										
Guara	Lyallpur	4·20	..	4·40	38·40	..	55·60*	0·63	1·34	Lander (3)
Gowar	Bombay	4·22	3·50	4·80	33·50	57·48*	..	0·40	0·71	..
Gowar	Bombay	6·02	5·66	6·40	46·60	40·98*	..	1·79	1·31	..
Gram dust	Pusa	5·55	4·61	2·51	17·48	27·01	47·45	..	..	Sen (2)
Gram *chuni*	Bombay	4·44	3·46	4·53	19·12	71·91*	..	0·81	0·66	..
Tur chuni	Bombay	6·22	4·32	2·23	25·52	66·03*	..	0·53	0·83	..
Wheat bran	Bangalore	5·50	4·64	3·45	15·41	10·70	64·79	0·25	1·98	Sen (2)
Wheat bran	Pusa	9·90	7·23	11·29	16·62	60·36	1·73	..	..	Sen (2)
Wheat bran	Lyallpur	6·80	..	11·50	12·23	54·10	4·40	0·23	2·00	Lander (3)
Wheat bran	Bangalore	4·90	..	13·60	9·60	57·30	3·10	0·22	1·75	Lander (3)
Long challa	Bombay	6·01	4·72	16·83	72·62*	..	4·54	0·31	2·96	Lander (3)
	Bombay	3·81	2·78	8·57	87·04*	..	0·58	0·66	0·38	

*Carbohydrates by difference.

Cottonseed contains maximum percentage of fat, with copra cake and *til* cake coming next. Groundnut cake also contains appreciable quantity of fat ; the other concentrates are poor sources of this nutrient.

Til cake contains the maximum percentage of ash soluble in HCl and calcium. However, wheat bran contains the maximum phosphorus.

Table II gives the results obtained by other workers in different parts of the country on these items.

It is seen from Table II that cottonseed available in Bombay is superior in ash content to those available in other parts of the country. The calcium content is also high. However, the phosphorus content is low. The protein content is also high, but only one sample from Lyallpur has higher percentage of protein.

Among the oilcakes, groundnut cake and *til* cake are richer in mineral matter, but copra cake from Bombay contains less ash than its counterpart from Cochin. The protein of groundnut cake compares favourably with that from Bangalore. The calcium content in the Bombay sample of groundnut cake is the highest while results of calcium analysis of *til* cake is not available. Copra cake from Bombay has very little calcium as compared to that from Cochin. The phosphorus contents of both groundnut cake and copra cake from Bombay are low.

Among the by-products, the second sample of *guar* from Bombay is rich in all the constituents. The contents of the first sample compare favourably with the sample from Lyallpur. The gram *churi* from Bombay has less ash content than its counterpart—gram dust—from Pusa, but is richer in protein and fat content.

No comparative figures for assessing the value of *tur churi* and long *challa* are available.

The wheat bran from Bombay has a lesser ash content than the other samples anlysed except those from Bangalore. The crude protein content and the fat content are higher than those of the other samples. The calcium and the phosphorus contents are the highest in the Bombay sample.

SUMMARY

1. Four batches of the following concentrates were analysed and their values compared with those obtained by other workers in different provinces—*guar*, gram *churi*, *tur-churi*, wheat bran, long *challa*, cottonseed, groundnut cake and *til* cake.

2. Cottonseed from Bombay had higher ash, and calcium and lower phosphorus content than those mentioned from other places.

3. Groundnut cake was richer in mineral matter and copra cake poorer than their counterparts from other places.

4. One sample of *guar* from Bombay was rich in all constituents, the other compares favourably with the sample from Lyallpur.

5. The crude protein, fat, calcium and phosphorus content of wheat bran from Bombay was higher than those of the other samples.

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ON A COLLECTION OF PARAMPHISTOMES FROM DOMESTICATED ANIMALS IN BIHAR

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(With Plate I)

IN recent years, investigations have proved that the livestock industry suffers much due to fatal gastro-enteritis caused by immature forms of various amphistome parasites. There is still much to be learned about the incidence and distribution of these common amphistomes in India and their specific pathogenicity and therapeutic. Bhalerao's [1935] work is too meagre for such a big country and in fact such undertakings should be on regional basis. Pande's [1935] report that the acute amphistomiasis of cattle in Assam was caused by immature forms of *Paramphistomum cervi* was later amended. Pande is said to have expressed the opinion that the immature forms were probably *Cotylophoron* sp. [Mudaliar, 1945], Moghe [1945] observed that infection of cattle with *C. cotylophorum* and *Gastrothylax crumenifer* was high in Central Provinces and Berar (now Madhya Pradesh). Srivastava [1945] carried out a general survey of helminthic infections of domestic ruminants in the Punjab, North-west Frontier Province and Sind and found the amphistomes, *C. cotylophorum*, *P. cervi*, *P. explanatum* and *G. crumenifer* in varying degrees of incidence in different hosts. He found that the species *P. cervi* and *G. crumenifer* were very common and widespread. Mudaliar (*loc. cit.*) records having recovered a few adult and some immature forms of *C. cotylophorum* and a very few specimens of *Fischoederius elongatus* causing fatal enteritis in goats in Madras "Pinjrapole goshala" and states that "there are more cases of amphistomiasis caused by immature forms of *Cotylophoron* species on record than by *Paramphistomum cervi* or any other amphistoma". He concludes with the following remarks :

"In the course of the routine *post-mortem* examination of ruminants, the writer has found adults of *Cotylophoron* species more frequently than *Paramphistomum* species. Hence the writer is inclined to think that the incidence of the species *Cotylophoron*, at any rate in South India, may be much more than that of *Paramphistomum*, though further statistical evidence of this is necessary."

Srivastava [1947] further reports in a subsequent communication that *G. crumenifer* is the common amphistome parasite in sheep, goats, cattle and buffaloes and has experimentally indicated its pathogenicity. D'souza [1948] also supports that *C. cotylophorum* and *G. crumenifer* are more common and widespread than

any other amphistome species in sheep and cattle in Hosur taluk of Salem district in Madras State. But, Ramkrishnan [1951] records having obtained from an outbreak of acute amphistomiasis in cattle in Nellore district of Madras only specimens, of mature and immature forms of *G. crumenifer* and *F. cobboldi* and remarked total absence of *C. cotylophorum*, which was almost a constant finding in other places. Anantaraman's [1954 unpublished] preliminary observations on the occurrence of amphistomes in Madras State tend to show that *P. cervi* may not be present there at all.

In the present paper a report is made on the occurrence of some members of this group, collected from domesticated animals in different geographical zones of the State of Bihar. This State lies over the Tropic of Cancer and certain parts of it possess ideal topographical features for the spread and propagation of trematode parasites, which have been discussed previously by the author [1954].

In the annual reports of the State Veterinary Department a few sporadic mentions have been made of the recovery of *P. cervi, P. expalnatum, C. cotylophorum, F. elongatus* and *G. crumenifer* here and there. Kuppuswamy [1946], while elucidating the etiology of ' Gillar ' and' Pitto ' (called ' *Chherrah* ' in Bihar) in sheep and goats, records having constantly recovered a large number of *P. cervi* sometimes along with a few *G. crumenifer* from these animals and later claimed that immature forms of *P. cervi* were the causative agents of the disease. In this connection the Indian Council of Agricultural Research commented later that *P. cervi* should be substituted by *C. cotylophorum*. This indicates the difficulty of distinguishing these two amphistomes in their very immature stages. Later investigations in this direction carried out by the writer and some of his associates in this State have resulted in the recovery of immature amphistomes mostly belonging to *Gastrothylax* sp. in significantly large numbers in animals suffering from ' *Chherrah* ', while immature *C. cotylophorum, Calicophoron calicophorum* were found in comparatively smaller numbers. These data tend to show that it is perhaps not any particular amphistome species that is responsible for setting up the condition popularly known as ' *Chherrah* ', but that all these immature intestinal amphistomes produce gastro-enteritis.

Material and Methods

During the period February to May, 1952, the author had the opportunity of collecting a large number of paramphistomes from cattle, buffaloes, sheep, goats, horses and pigs from different geographical zones in the State of Bihar. These collections were made during autopsies at veterinary institutions and abottoirs. The worms were all fixed in 10 per cent hot formol-saline while still alive. Further collections were made during 1953 and 1954. The material included several genera of the family Paramphistomidae Fischoeder, 1901, and a short account of them is given here. The identification rests on the examination of whole-mounts and hand-sections of some of the specimens. Wherever necessary, histological studies were also made on a few specimens.

Tables I, II and III furnish the number of animals examined and found infected with various amphistomes in different localities of the State together with incidence of infection with each species.

TABLE I
Incidence in cattle and buffaloes

Locality	No. of animals examined		No. found infected with *C. cotylophorum*		No. found infected with *C. calicophorum*		No. found infected with *G. crumenifer*		No. found infected with *Gigantocotyle explanatum*	
	C	B	C	B	C	B	C	B	C	B
Patna	48	4	26	1	6	..	36	4	..	..
Arrah	..	4	..	2	..	..	..	4	..	2
Biharsharif	3	1	1	1	1	..	2	1	..	1
Nawada	5	1	3	1	2	..	3	1	..	1
Bhagalpur	14	8	6	4	2	1	10	8	..	6
Supaul	2	..	2	..	1	..	2	..	..	..
Pipra Bazar	1	..	..	..	..	..	1	..	..	..
Purnea	1	2	1	2	1	1	1	2	..	2
Kishanganj	20	..	6	..	1	..	20	..	..	..
Araria	2	1	2	1	1	1	2	1	..	..
Total	96	21	47	12	15	3	77	21	..	12

C=Cattle; B=Buffaloes.

TABLE II

Incidence in sheep and goats

Locality	No. of animals examined		No. found infected with *C. cotylophorum*		No. found infected with *C. calicophorum*		No. found infected with *G. crumenifer*	
	S	G	S	G	S	G	S	G
Patna	16	22	10	14	4	6	10	12
Arrah	..	6	..	3	..	2	..	5
Daltonganj	1	..	1	..	1	..	1	..
Supaul	..	10	..	6	..	1	..	10
Bariahi	..	24	..	14	..	6	..	22
Pipra Bazar	..	5	..	3	..	1	..	5
Madhepura	..	7	..	4	..	..	..	6
Purnea	..	4	..	3	..	..	..	4
Kishanganj	..	24	..	11	..	2	..	7
Katihar	3	35	1	8	1	2	1	2
Araria	..	17	..	7	..	3	..	2
Total	20	154	12	73	6	23	12	75

S=Sheep; G=Goats.

TABLE III

Incidence of specific infections in different hosts

Amphistome species	Hosts and number of animals examined											
	Cattle-96		Buffaloes-21		Sheep-20		Goats-154		Horse-7		Pigs-8	
	No. infected	Incidence (Per cent)	No. infected	Incidence (Per cent)	No. infected	Incidence (Per cent)	No. infected	Incidence (Per cent)	No. infected	Incidence (Per cent)	No. infected	Incidence (Per cent)
1. *Cotylophoron cotylophorum*	47	48·9	12	57·1	12	60	73	47·4	..	..	..	..
2. *Gastrothylax crumenifer*	77	80·2	21	100	12	60	75	48·7	..	..	..	..
3. *Calicophoron calicophorum*	15	15·6	3	14·2×	6	30	23	14·9	..	..	..	..
4. *Gigantocotyle explanatum*	..	..	12	57·1	..	..	..	..	..	..	..	..
5. *Pseudodiscus collinsi*	..	..	..	..	..	..	..	..	7	100	..	..
6. *Gastrodiscus secundus*	..	..	..	..	..	..	..	..	3	42·8	..	..
7. *Gastrodiscoides hominis* var. *suis*	..	..	..	..	..	..	..	..	..	..	1	12·5

Although the number of animals examined in different localities was not large, the figures in Table I to III suggest that *G. crumenifer* is the commonest and most widespread amphistome in Bihar. In some animals it was found as the sole infection and its immature forms were present in large numbers setting up severe fatal enteritis. *C. cotylophorum* is also quite common, particularly in sheep and goats; but it is noteworthy that not a single example of *P. cervi* was found during this survey. *G. explanatum* was found to occur in buffaloes only in the bile ducts and it was never seen in cattle or sheep and goats. *C. calicophorum*, which has been considered by many authors as a synonym of *G. explanatum*, was recovered many a time from the stomach of cattle, buffaloes, sheep and goats. This parasite is maintained in this paper as a separate species and its distinguishing features have been discussed. *Pseudodiscus collinsi* was found to be a common parasite of horses.

Observations

I. Genus COTYLPHORON Stiles & Goldberger, 1910

Species C. cotylophorum (Fischoeder, 1901)

Host: Cattle (*Bos indicus*), buffaloes (*Bos bubalus*), sheep (*Ovis aries*) and goats (*Capra hircus*)

Habitat: Rumen and reticulum. Immature forms were found in the abomasum and duodenum

Localities: Patna, Arrah, Bhagalpur, Supaul, Bariahi, Pipra Bazar, Madhepura, Purnea, Kishanganj, Katihar, Araria, Biharsharif, Nawada and Daltonganj

This species was found frequently in all the localities visited during this investigation, and was particularly frequent in sheep and goats. The total incidence of infection with this amphistome was found to be 49·4 per cent. From a few cases of '*Chherrah*' in young calves, sheep and goats quite a large number of young 'forms identifiable as this species, were collected from the abomasum and duodenum, particularly the pyloric region, and these organs were highly congested, inflamed and oedematous and sometimes gelatinised. The worms were invariably found together with immature forms of *Gastrothylax* sp., which were also present in large numbers.

This species (*C. cotylophorum*) in its living state is easily distinguishable from others by its purple colour. The characteristic genital sucker is also demonstrable even in very small young forms by flattening the living specimen between two slides and also by making histological preparations of well-preserved specimens.

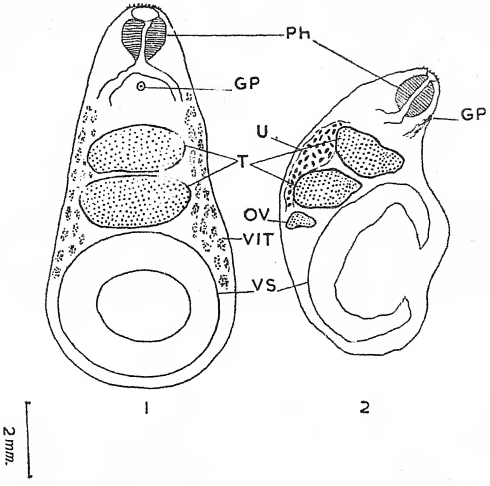
II. Genus GASTROTHYLAX Poirier, 1883

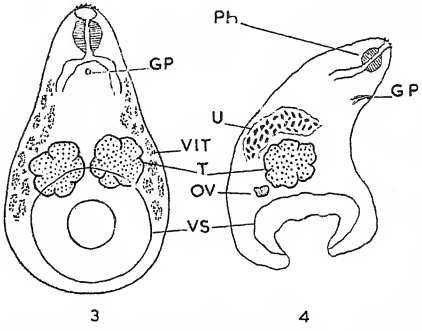
Species G. crumenifer (Creplin, 1847)

Host: Cattle, buffaloes, sheep and goats

Habitat: Rumen and reticulum; young forms in abomasum and duodenum

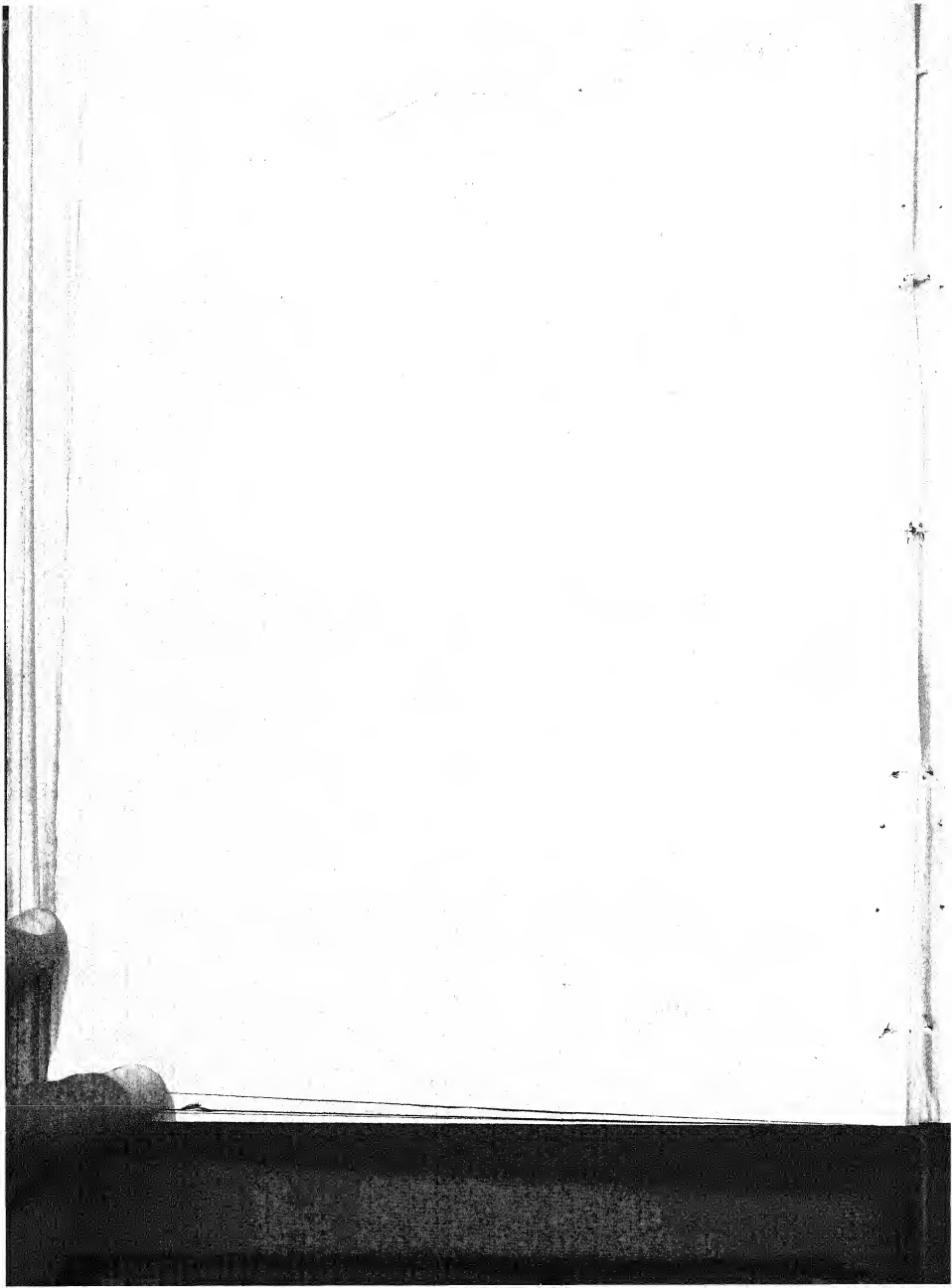
Localities: All the places visited as stated earlier





FIGS. 1 and 2—*Gigantocotyle explanatum*
,, 3 and 4—*Calicophoron calicophorum*
,, 1 and 3—Horizontally bisected specimens
,, 2 and 4—Sagittally bisected specimens

Ph — Pharynx ; GP — Genital pore ; U — Uterus ; T — Testes ; OV — Ovary ; Vit — Vitellaria ; VS — Ventral sucker



This was found to be the commonest species throughout the State, its total incidence being 63·2 per cent. It was also observed that this species occurs in much greater numbers in buffaloes than in other hosts and in a few animals that died of parasitic enteritis (acute amphistomiasis) it was found to occur as the sole infection in a very large number. This is interesting and lends support to Srivastava's [1947] laboratory experimentations regarding the pathogenicity of this species.

The ventral pouch, characteristic of this group of amphistomes, was not found developed in very small young forms and this might have misled early workers to identify these as *P. cervi*. In this study the identification was mostly inferential. Those undeveloped very small young forms were taken as belonging to this species, as in the same case a large number of amphistomes in different developmental stages showing characteristic features of *G. crumenifer* was found as sole infection. In cases where there was mixed infection with this parasite as well as *C. cotylophorum C. calicophorum*, the latter two were easily identified by their distinguishing features discussed in this paper.

III. Genus GIGANTOCOTYLE Nasmark, 1937

Species G. explanatum (Creplin, 1847)

(Figs. 1 and 2)

Host: Buffaloes (*Bos bubalus*)

Habitat: Bile ducts

Localities: Arrah, Bhagalpur, Purnea, Biharsharif and Nawada

Out of a total number of 21 buffaloes examined, 12 or 57·1 per cent were found infected with this species. It is interesting that this parasite was not found in any other host, although the infection was very heavy in most of the buffaloes found infected.

This species was discovered by Creplin [1847] in the bile ducts and gall bladder of what he called *Bovis tauri* indict at Berlin (Germany). Fischoeder [1904] records having examined specimens of this species from the bile ducts of the zebu at Berlin and also *Buffelus indicus* of Saigon (Cochin-China). Dawes [1936] examined some specimens of this parasite from the bile ducts of Malayan cattle, buffalo and goats. In India, Bhalerao [1935] records the parasite from both cattle and buffaloes occurring in their bile ducts, gall bladder, stomach and duodenum; but then he considered *Paramphistomum calicophorum* under the synonymy of this species. Srivastava [1945] also records it from both these hosts, but it is not clear from his writings whether he made any distinction between these two species, nor does he mention the locations of the parasites in the hosts.

These amphistomes have large ventral suckers measuring 3·4 to 4·2 mm. in diameter and the body length measures from 9 to 10·5 mm. in preserved specimens (measurements were taken from 20 specimens), giving a ratio of the diameter of

the ventral sucker to the length of the body as 1 : 2·5-2·6. The testes are characteristically placed one behind the other, the anterior one inclined more ventrad. The parasites have a characteristic habitat, namely, in the bile ducts. These are the main characters on which the identification of the species is based.

IV. Genus CALICOPHORON Nasmark, 1937

Species C. calicophorum (Fischoeder, 1901)

(Figs. 3 and 4)

Host : Cattle, buffaloes, sheep and goats

Habitat : Rumen and reticulum

Localities : Patna, Bhagalpur, Supaul, Bariahi, Madhepura, Pipra Bazar, Purnea Kishanganj, Katihar, Araria, Biharsharif, Nawada and Daltonganj

This species was also occasionally met with, the total incidence being 16·1 per cent ; but the degree of infection was never found to be heavy in any case. Unlike other intestinal amphistomes this parasite has a large ventral sucker measuring about 3 mm. in diameter. The body-length of the parasite measures about 8 mm. (average of 20 specimens). Thus, the ratio of the diameter of the ventral sucker to the body-length is 1 : 2·6. The testes are lobulated like a cauliflower and are situated side by side at the mid-level of the body. Owing to these distinctive morphological characters coupled with the characteristic habitat of the parasite, it was identified as *C. calicophorum*.

Maplestone [1923], while reviewing the family Paramphistomidae, records having examined some material from the stomachs of bullocks of South Africa, Australia, Sudan and Nyasaland which he identified as *Paramphistomum explanatum*. He further proposed a drastic synonymisation in this group and considered Fischoeder's *Paramphistomum calicophorum* under the synonymy of *P. explanatum*. Apart from overlooking the morphological differences between these two forms, it is apparent, Maplestone ignored altogether the specific habitat of the parasite in the host. The testes in Maplestone's specimens were always diagonally situated, one overlapping the other, both laterally and antero-posteriorly, in fully grown worms. Swart [1954], however, considers this African species as *C. calicophorum*. A few examples of these African amphistomes from the rumen of cattle were examined by the author through the kind courtesy of Dr. P. L. LeRoux and Maplestone's observations in respect of the obliquely tandem disposition of the testes were confirmed. In the Indian collection from Bihar the specimens of this parasite did not appear to be fully grown ones, although some of them were gravid judging by the presence of ova in their uteri. The testes in these are placed exactly side by side and it is quite probable that with the maturity of the parasite this arrangement is affected by voluminous development of the gravid uterus causing an obliquity in their disposition.

This parasite, as far as the writer is aware, has not been recorded hitherto from sheep and goats in India, hence this is a new record. It is also noteworthy that very small young forms of this species may be mistaken for *P. cervi*. Durie [1951],

while studying the texonomy of Paramphistomes in cattle in Australia has also shown that the species previously identified as *Paramphistomum cervi* is in reality two species, namely, *Ceylonocotyle streptocoelium* and *Calicophoron calicophorum*.

V. Genus PSEUDODISCUS Sonsino, 1895

Species P. collinsi (Cobbold, 1875)

Host : Horse (*Equus caballus*)

Habitat : Colon

Localities : Patna, Arrah and Nawada

All the seven horses examined at the above localities were found infected, which suggests that it is a common parasite of horses in this State. Very little is known about the pathogenecity of this amphistome, but from one animal about 2,000 specimens were recovered and the host was anaemic and debilitated.

VI. Genus GASTRODISCUS Leuckart, 1877

Species G. secundus Looss

Host : Horse

Habitat : Colon

Localities : Patna

Out of seven horses examined only 3 were found infected with this parasite. The infection was very light in all the infected animals.

VII. Genus GASTRODISCOIDES Leiper, 1913

Species G. hominis var. suis (Varma, 1954)

Host : Pig (*Sus cristatus*)

Habitat : Large intestine

Localities : Forbesganj (Purnea district)

After administering soap-water enema to 8 pigs a single specimen of this parasite was obtained from one of these animals. This has been morphologically and epidemiologically distinguished by the author [1954] from *G. hominis* and named *G. hominis* var. *suis* and in absence of any recorded evidence this represents the first record of the parasite in this host in the State of Bihar.

SUMMARY

Seven species of amphistomes, representing seven genera, are recorded from different localities from domesticated animals from the State of Bihar. *Gastrothylax crumenifer* was found to be the commonest and most widespread species in the State. *Calicophoron calicophorum*, whose distinguishing features from *Gigantocotyle explanatum* are discussed, is recorded for the first time from Indian sheep and goats. The latter parasite (*G. explanatum*) was found to occur only in buffaloes in the bile ducts. *Pseudodiscus collinsi* is recorded as a common parasite of horses.

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Review

Veterinary Clinical Diagnosis by Prof. David Wirth, 1st English translation by Annie I. Littlejohn.

Published by Bailliere Tindall and Cox, London. Pages 232 with 213 illustrations. Price 25 $.

Books on clinical diagnosis of the diseases of domestic animals are scarce, at least in English language. The art of diagnosis is acquired largely by personal observation and experience through a number of years. Availability of an up-to-date, handy and well-illustrated book on the subject has greatly facilitated a sound preliminary training of the students in veterinary medicine. Those of us who have profitably used the *Clinical Diagnostics* by Malkmus in our student days would readily applaud the present attempt and welcome this valuable addition to the English veterinary literature. It should prove very useful to teachers as well as those engaged in the field investigation of animal diseases.

This is the first English edition of Professor Wirth's book, "*Introduction to the clinical diagnosis of the diseases of the internal organs and skin of the domestic animals*", the first Austrian edition of which was published in 1934 and the third in 1949. The English edition, however, is not merely a translation of the third Austrian edition, as it incorporates many additions and alterations with a view to improve the text to "meet the needs of British students mainly on account of differences in the incidence of certain diseases and in the relative importance of the various species". In part or whole of certain chapters "this adaptation has amounted to complete rewriting". Similarly, 92 new illustrations have been added, "the majority of them being from photographs specially taken for this edition, and relating mainly to the examination of food-producing animals". About 30 illustrations included in the Austrian edition have been either ommitted or reproduced only in part.

The book is divided into 36 chapters of different sizes, dealing with general examination of the animals, signs of disturbances in the working of the various systems, examination of faeces and urine, radiography, exploratory puncture and biopsy, allergic tests, serological examination, and clinical methods of examination applicable to individual organs. It is written in very simple and lucid language, and the text is profusely supplemented by examples drawn from a large variety of disease conditions.—R.N.M.

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ERRATA

Indian Journal of Veterinary Science and Animal Husbandry, Vol. XXVI, Part III, September, 1956

Page	Line	*For*	*Read*
111	11th from bottom	absorption	adsorption
113	Table I, Col. I, No. 35	p-amino-phenylpyridine	p-amino-x-phenylpyridine

NOTE ON THE OCCURRENCE OF ATYPICAL STRAINS OF FOOT-AND-MOUTH DISEASE VIRUS IN INDIA*

By M. R. Dhanda, V. R. Gopalakrishnan and H. S. Dhillon,
Indian Veterinary Research Institute, Mukteswar—Kumaon, U.P.

[Received for publication on July 23, 1955
Accepted for publication on August, 1957]

A scheme of research financed by the Indian Council of Agricultural Research, is being operated at the Indian Veterinary Research Institute, Mukteswar, with the object of devising a suitable method of vaccination for the control of foot-and-mouth disease among cattle in India. The disease is widespread in this country and causes substantial loss to the cultivators. It is caused by three distinct immunological types of the virus known as Vallee "O" and "A" and Waldmann "C".

A number of outbreaks of the disease caused by one or the other of these types occur annually in various parts of the country but the clinical manifestation in the affected animals is the same for all the types. As the types of the virus are immunologically distinct from one another, any attempt at vaccination as a measure of control of the disease should necessarily contain the representative types that cause the epizootics. In order to have an idea of the frequency and distribution of the occurrence of the different types, fresh material was obtained from natural outbreaks in the fields and typed by cross immunity test in guinea pigs. In the course of type determination, variants of the three standard types of the virus have been observed to cause outbreaks in this country [Seetharaman and Dutt, 1951]. The occurrence of atypical strains of foot-and-mouth disease virus is of interest and, therefore, is recorded in this article. An analysis of the results of typing of 72 field strains of the virus isolated from different parts of India, showing the frequency distribution of the various types is given in Table I

Atypical strains

The first atypical strain was isolated from the material collected from a buffalo in an outbreak at Rawalpindi (Punjab), and sent to the Institute in April, 1944. After adaptation of the strain of virus to guinea pigs, cross immunity tests were carried out to determine the type. It was found to be quite distinct from the standard types as it broke immunity against all of them, each of which in turn broke immunity against it. Its behaviour continued to remain unaltered after 61 guinea pig passages.

* Paper read at the Indian Science Congress held at Hyderabad in January 1954.

TABLE I

Distribution of various types of foot-and-mouth disease virus in India

Place of origin State	Types						
	'O'	'O' variant	'A'	'A' variant	'C'	'C' variant	Atypical
Andhra Pradesh	1	1	..	..	..	..	..
Assam	..	1	..	..	..	..	..
Bengal	..	..	..	..	..	1	..
Bihar	..	1	..	..	..	..	..
Bombay	1	1	..	1	..	..	..
Himachal Pradesh	1	..	..	..	..	..	..
Jammu and Kashmir	..	1	..	..	..	..	..
Madhya Pradesh	..	..	..	1	..	1	..
Madras	..	..	..	1	1	..	..
Orissa	1	1	..	1	..	..	..
Punjab	1	..	..	3	..	..	..
Uttar Pradesh	17	9	5	9	1	2	3
Areas now in Pakistan	2	1	..	..	..	1	1
Total	24	16	5	16	2	5	4
Percentage	33·3	22·2	7·0	22·2	2·8	7·0	5·5

Two strains were obtained from natural outbreaks at the Indian Veterinary Research Institute, Izatnagar in May, 1951. Izatnagar is about 1000 miles south-east of Rawalpindi area. Material was collected from fresh cases at the Izatnagar Dairy as well as from animals of the Animal Nutrition Division. These two strains were found atypical, brea king immunity against the standard types. However, they were immunologically identical.

Again there was an outbreak of the disease among cattle of the Animal Nutrition Division, Izatnagar in April, 1952. Fresh material was collected and this strain also proved to be atypical and immunologically identical with the Izatnagar strain of 1951.

These Izatnagar strains have each undergone more than a dozen guinea-pig passages. They maintain their immunological character.

A noteworthy observation in regard to the atypical strains in general is their easy and rapid adaptability to guinea pigs. From the second passage they are adapted to guinea pigs, showing the characteristic primary lesions followed by generalization.

Cross-immunity test

All the cross-immunity tests were carried out in guinea pigs. First, guinea pigs immune to standard type "O", "A" and "C" (Pirbright) and those against other atypical strains were tested with the Rawalpindi atypical strain (Table II). Then guinea pigs immune to Rawalpindi strain of virus were tested with standard types "O", "A" and "C" (Table III). Again, Izatnagar Dairy atypical strain was given to immune guinea pigs of all the strains (Table IV). Similarly, the guinea pigs immune to all the strains under experiment were tested with Izatnagar Animal Nutrition Division atypical strain (TableV).

The observation of the tests were :

(1) Each atypical strain evidently had homologous immunity.

(2) All the atypical strains broke immunity against the three standard types, each of which in turn broke immunity against the atypical strains.

(3) The three Izatnagar atypical strains were immunologically identical.

(4) Rawalpindi atypical strain was immunologically distinct from the Izatnagar atypical strain.

Discussion

The occurrence of the three standard types and their variants causing outbreak of the disease has been observed in this country.

Apparently atypical strains, immunologically distinct from one another caused repeated outbreaks of the disease at Izatnagar causing difficulties for the control of foot-and-mouth disease by vaccination. It has been shown that variants of the same type have different antigenic structures and the antigenic properties in turn vary from strain to strain [Ubertini, 1951]. A recent epizootic in Europe was characterised by the spontaneous appearance of variants of the virus [Ramon, 1952] and vaccines failed to control the spread of infection due to the presence of variants of type, antigenically different from one another [Lancet, 1952]. It is generally believed that variants and perhaps atypical strains are heterologous composites derived for the standard types. When the question of control by vaccination of the epizootic caused by variants of types is so unsatisfactory, the control of the disease caused by atypical strains would be more complicated.

Note : Since this article was sent out for publication, the Rawalpindi strain, the Izatnagar 51 and 52 strains were sent to the Virus Research Institute, Pirbright (England) for confirmation of the findings. The atypical character of the Izatnagar strains has been confirmed by the workers at Pirbright, whereas in respect of the Rawalpindi strain it was reported to correspond to classical type 'O' virus. On scrutiny of the record of the Rawalpindi strain, it was found that it was typed last at this Institute at guinea pig passage No. 58 and was atypical in character beyond any doubt. The material despatched to Pirbright was from guinea pig passage No. 74. Since the chances for the cross contamination of the virus while being handled in the laboratory are considered very remote, it appears, that the virus changed in its antigenic character somewhere between passage No. 58 and 74 by shedding off its heterologous components and reverted to the type 'O' virus.

The atypical Izatnagar strain has since been designated as Asia I.

TABLE II

Cross immunity test with Rawalpindi atypical strain of virus

Guinea pig No.	Immune to type	Interval between immunisation and test (days)	Days:	1	2	3	4	5	6	7	8
			Date:	22	23	24	25	26	27	28	29
120	Pirbright "A"	53		+0	++	++	++	++	++	++	
121	do.	53		+0	++	++	++	++	++	++	
102	Pirbright "O"	58		+0	++	++	++	++	++	++	
103	do.	58		+0	++	++	++	++	++	++	
126	Pirbrigh "C"	52		+0	++	++	++	++	++	++	
127	do.	52		+0	++	++	++	++	++	++	
153	I. S. Izat., A.N.S.	47		+0	++	++	++	++	++	++	
180	do.	38		+0	++	++	++	++	++	++	
146	I.S. Izat., Dairy	48		+0	++	++	++	++	++	++	
147	do.	48		+0	++	++	++	++	++	++	
160	I.S. 19 Rawalpindi	44		00	00	00	00	00	00	00	
161	do.	44		00	00	00	00	00	00	00	

Note: (1) The guinea pigs were tested on June 22, 1952 with I. S. 19 Rawalpindi strain collected from guinea pigs on June 9, 1952.
(2) 00, +0 and ++ represent "no reaction", "local reaction" and "local reaction plus generalisation" respectively.

TABLE III

Cross immunity with standard type "O", "A" and "C" virus of guinea pigs immunised against I.S. 19 Rawalpindi strain

Guinea pig No.	Interval between immunisation and test (days)	Tested with strain	Reaction after test. Days:	1	2	3	4	5	6	7	8
			Date:	14	15	16	17	18	19	20	
296	33	Pirbright "A"		+0	+0	+0	+0	++	++	++	++
302	33	do.		+0	+0	+0	++	++	++	++	++
304	35	Pirbright "O"		+0	+0	++	++	++	++	++	++
305	35	do.		+0	+0	++	++	++	++	++	+·
308	34	Pirbright "C"		+0	+0	++	++	++	++	++	++

Note: +0 and ++ represent "local reaction" and "local reaction plus generalisation," respectively.

TABLE IV

Cross immunity test with Izatnagar Dairy atypical strain of virus

Guinea pig No.	Immune to type	Interval between immunisation and test (days)	Reaction after test. Days:	1	2	3	4	5	6	7	8
			Date:	19	20	21	22	23	24	25	26
118	Pribright "A"	50		+0	+0	++	++				
119	do.	50		+0	+0	++	++				
100	Pirbright "O"	56		+0	+0	++	++				
101	do.	56		+0	+0	++	++				
124	Pirbright "C"	49		+0	+0	++	++				
125	do.	49		+0	+0	++	++				
158	I.S. 19 Rawalpindi	41		+0	+0	++	++				
159	do.	41		+0	+0	++	++				
151	I.S. Izat. A.N.S.	44		00	00	00	00				
152	do.	44		00	00	00	00				
144	I.S. Izat. Diary	45		00	00	00	00				
145	do.	45		00	00	00	00				

Notes: (1) The guinea pigs were tested on June 19, 1952 with I.S. Izat. Dairy strain collected from guinea pigs on June 14, 1952

(2) 00, +0 and ++ represent "no reaction," "local reaction" and "local reaction plus generalisation", respectively.

TABLE V

Cross immunity test with I.S. Izatnagar A.N.S. atypical strain of virus

Guinea pig No.	Immune to type	Interval between immunisation and test (days)	Days:	1	2	3	4	5	6	7	8
			Date:	16	17	18	19	20	21	22	23
116	Pirbright "A"	47		+0	+0	+0	++	++	++		
117	do.	47		+0	+0	++	++	++	++		
98	Pirbright "O"	53		+0	+0	++	++	++	++		
99	do.	53		+0	+0	+0	++	++	++		
122	Pirbright "C"	46		+0	+0	+0	++	++	++		
123	do.	46		+0	+0	++	++	++	++		
156	I.S. 19 Rawalpindi strain	38		+0	+0	++	++	++	++		
157	do.	38		+0	+0	++	++	++	++		
142	I.S. Izatnagar Diary strain	42		00	00	00	00	00	00		
143	do.	42		00	00	00	00	00	00		
148	I.S. Izatnagar A.N.S. strain	41		00	00	00	00	00	00		
149	do.	41		00	00	00	00	00	0		

Notes: (1) The guinea pigs were tested on June 16, 1952 with I.S Izatnagar A.N.S. strain collected from guinea pigs on June 15, 1952

(2) 00, +0 and ++ represent "no reaction" "local reaction" and "local reaction + generalisation", respectively.

Summary

An analysis of the results of typing of 72 strains of foot and-mouth Disease virus isolated from different parts of India shows that the frequency distribution of the various types is as follows :

Vallee "O"	24	"O" Variant	16	55·6 per cent
Vallee "A"	5	"A" Variant	16	29·1 per cent
Waldmann "C"	2	"C" Variant	5	9·7 per cent
Atypical	4	——	——	9·6 per cent

Variants of the three types of the virus Vallee "O", and "A" and Waldmann "C" have been observed to occur in various parts of the country. The occurrence of four atypical strains of Foot-and-Mouth Disease virus is recorded. A noteworthy feature is the occurrence of immunologically identical atypical strains causing repeated outbreaks of the disease. However, the atypical strains obtained from Izatnagar were found to be immunologically distinct from the atypical strain from Rawalpindi, nearly a thousand miles away.

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SEX MATURITY IN DAIRY CATTLE AND THE PROBABLE CAUSES OF DELAYED PUBERTY

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(With 4 Text Figures)

INFERTILITY and delayed maturity in dairy animals are important factors that limit the development of dairy industry in this country. Infertility in animals, whether temporary or permanent, is a great liability which tells severely on the economic resources of our farmers.

Of late, organised attempts have been made to study the various factors responsible for delayed maturity in dairy herds. The different factors of the infertility problem are also being actively persued. Little is known about the age at first calving amongst the various breeds of cattle in India, as also the influence of sire or the effect of better feeding on the onset of early maturity.

The introduction of the recent legislation has complicated the issue and made the disposal of these unprofitable animals further difficult. The problem has thus assumed a serious proportion not only with private individuals but even in State managed farms where cattle are normally kept in a better condition.

It has, therefore, been considered necessary to carry out some systematic work on the various aspects of infertility and late maturity in cattle. In this article an attempt has been made to give an account of these investigations in four parts as follows:

(*a*) The determination of the age at first calving in various State managed farms

(*b*) The influence of sire on the age at first calving

(*c*) The percentage of abnormal animals in the age group in different herds

(*d*) The effect of feeding on sex maturity in dairy animals

(*a*) *Age at first calving in different farms*

A survey of the State farms in Uttar Pradesh was carried out at 6 centres and in all, records of 434 heifers of Hariana breed were analysed. All the heifers were farm-bred and had their first calving at the farm. A general idea regarding the method of feeding and the environment in which they live in these farms during early life may be obtained from the following:

Feeding: The animals at these farms are fed a prescribed ration. If the article mentioned in the ration schedule is not available, some alternative feed having

almost the same nutritive value is included as an emergency measure. Although the ingredients of the ration may vary to some extent from centre to centre, the effect of the whole ration on the basis of digestible nutrients is more or less the same in all the centres.

Management

The environment in which cattle generally live in these farms may be considered satisfactory and is more or less uniform. There may, however, be some variation in the management. The animals are generally not tied and are fed in lots of 15 to 30 in a common feeding trough where the feed for the lot is distributed in a long feeding channel.

The age at first calving in Hariana heifers is given in Table I. In calculating the age at first calving, only those neifers which calved between the age of 3-5 years have been considered. Heifers which calved later were thought to be abnormal cases. The number of heifers considered at each farm for calculating the average is shown in parenthesis. The average age at first calving at the different farms varied from 1262 days (approximately 42 months) at Babugarh to 1693 (approximately 56¼ months) at Nilgaon. The minimum age at which the heifer had calved was 895 days (approximately 30 months) and the maximum 2659 days (approximately 7¼ years).

TABLE I

Comparative statement showing the age at first calving in the Hariana breed at the cattle farms in Uttar Pradesh

Name of the Farm	Age at first calving in days			Remarks
	Average	Range		
		Minimum	Maximum	
1. Mechanised State Farm, Madhurikund	1546(95)	1013	2659	
2. Mechanised State Farm, Bharari	1683(135)	1112	2337	
3. Mechanised State Farm, Babugarh	1262(61)	895	1817	
4. Mechanised State Farm, Hastinapur	1498(26)	995	1825	
5. Mechanised State Farm, Nilgaon	1693(54)	1115	2262	
6. District Dairy Demonstration Farm, Mathura	1544(63)	898	2264	
Average age at 1st calving in the Hariana breed			1538±65 days (approximately 51 months)	

Among other Indian breeds of cattle, the age at first calving has been determined as 1331·3±16·9 days in Sindhi and 1447±60·2 days in Kangyam [Rajgopalan 1952]. Sharma [1951] found the age at first calving in Hariana as 1618 ±10·5 days which is not very much different from what we have seen in Uttar Pradesh.

TABLE II

Influence of the sire on the age at first calving

	Names of farms									
	Madhurikund				Bharari				Nilgaon	
	Brand No. of the bull				Brand No. of the bull				Brand No. of the bull	
	243	359/6	19/P6	14/104	800	243	154	270	737/19	379/PI
Average age of the heifers at first calving from each bull	1478·5 ±76·0 (8)	1498·2 ±49·6 (7)	1447·0 ±40·8 (7)	1515·7 ±40·7 (11)	1517·4 ±24·2 (41)	1425·9 ±66·9 (9)	1592·4 ±44·0 (8)	1371·8 ±42·9	1464·4 ±46·9 (12)	1665·3 ±28·5 (10)

(*b*) *Influence of the sire on the age at first calving*

In this study, the data on the age at first calving was tabulated according to the sires of these heifers. Sires which had at least 6 daughters were considered. The study was limited to 10 bulls at 3 places viz. Madhurikund, Bharari, Nilgaon ; and the total number of animals under this study was 120 heifers.

The average age at first calving with their standard error is given in Table II.

The analysis of variance was made to find out the difference between bulls at Madhurikund. It was not significant.

At Bharari Farm, the analysis of variance between bulls was significant at 5 per cent level. The bull No. 270 appeared to be different from the bull No. 154 in dropping heifers of varying age at first calving. The bull No. 270 dropped early calvers, while bull No. 154 dropped late calvers.

The difference between the bulls used at the Farms was not very conspicuous regarding this character, as the breeding bulls were not selected with this character in view. All the bulls used were of average merit and, therefore, did not influence appreciably the age of the heifers at first calving. The problem could be approached from another angle. If the age of the mothers (dams) at first calving was known then the age of the heifers could be compared over the dams, as is done in the case of progeny testing of bulls for milk yield. It appears that if bulls coming from early maturing families are selected, it would be possible to reduce the age at first calving.

(*c*) *Heifers which calve either late or early at different farms*

In every species there is a physiological age at which the reproductive organs become active, and simultaneously changes take place in the ovaries, uterus and mammary glands. The female becomes capable to carry the young. This is called the age of puberty or the age of maturity. Females, in which this occurs late, may be considered as pathological cases. In scientific terminology there are cases of infertility in young animals which cause heavy economic losses to the cattle breeders.

TABLE III

Incidence of infertility (late maturity) in heifers

Name of the Farm	Total No. of heifers considered	No. of heifers calving before 3 years	No. of heifers calving after 5 years	Remarks
Mechanised State Farm, Madhurikund	95	2	15	
Mechanised State Farm, Bharari	135	..	12	
Mechanised State Farm, Babugarh	61	5	..	
Mechanised State Farm, Hastinapur	26	1	2	
Mechanised State Farm, Nilgaon	54	..	13	
District Dairy Demonstration Farm, Mathura	63	6	12	
TOTAL	434	14	54	

The percentage of early and late calvers works out to be 3·2 and 12·4 respectively. The early calvers indicate that we can possibly reduce the age at first calving in our farms. The late calvers are cases of infertility where either the maturity was too much delayed or the animals did not conceive.

(*d*) *The effect of feeding on sex maturity in dairy animal*

In these investigations an attempt was made to study the effect of feeding a cheaper, but otherwise adequate, roughage ration on the maturity in dairy animals as compared with a costlier ration consisting of wheat *bhusa*, concentrate mixture and a little green.

Sixteen comparable female calves of about one-and-a half year old were selected and divided into two groups, eight in each. To start with, the roughage group was fed a ration consisting of 30 lb. green berseem and 5 lb. wheat *bhusa* (9·0—0·6—5·3)*, while the concentrate group 5 lb. wheat *bhusa*, 3½ lb. balanced concentrate mixture and 5 lb. of green berseem (8·5—0·62—5·1). The rations in both the groups were adjusted from time to time according to the requirement of the animals. The maximum allowance given to the roughage group was 40 lb. green berseem and 6 lb. wheat *bhusa* (11·4—0·8—6·8) and concentrate group 6 lb. wheat *bhusa*, 5 lb. concentrate mixture and 5 lb. green berseem (10·7—0·85—6·6). When green berseem was not available, the ration was balanced by equivalent amount of berseem hay.

During the first 3-4 months of the experiment, condition of the animals in both the groups was more or less similar. Thereafter, the concentrate group showed accelerated growth so much so that at the end of about 8 months, the animals in the roughage group looked very much dwarfed in comparison to the concentrate group.

The total ingestion of phosphorus in the roughage group varied between 5-7 gm. and calcium 50-65 gm., while in the concentrate group, phosphorus 10-15 gm. and calcium 14-16 gm.

The content of copper in the whole blood of the two groups of animals, as measured by Eeel's photo-electric colorimeter, was normal, though the concentrate group invariably showed higher values than the roughage group.

It is obvious from the data shown above that the all-roughage ration, though otherwise adequate in protein and energy, definitely suffers from a shortage of phosphorus. This low ingestion of phosphorus coupled with a wide ca/p ratio (10 : 1) is considered inadequate during the active period of growth. The reproductive failure brought about by a ration of this kind is discussed below.

Reproductive data

In the concentrate group the average age of the heifers when they showed their first oestrum was 2 years 9 months. Six heifers out of 7 (the best animals died of snake bite) conceived early.

* The figures in the brackets indicate the level of nutrition in lb. as dry matter, digestible crude protein and total digestible nutrients respectively.

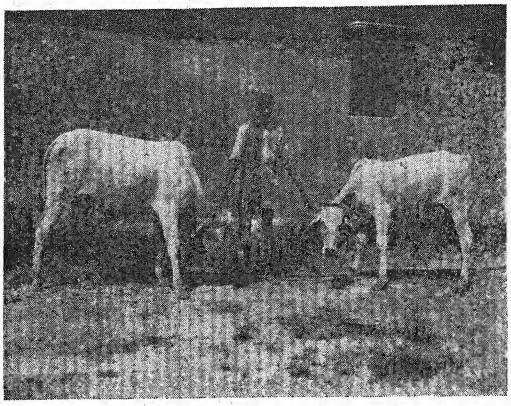

Fig. 1. Heifer on the left was fed on a ration of wheat *bhusa* (5 lb.), concentrate mixture (3½ lb. and a little green berseem (5 lb.). Heifer on the right is of the same age but was fed a ration of green berseem (30 lb.) and wheat *bhusa* (5 lb.) and no concentrates

Fig. 2. Back view of the animals shown in Fig. 1 (compare the size)

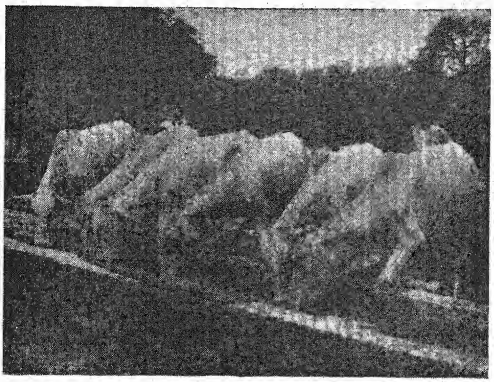

Fig. 3. A group of heifers on a balanced diet of roughage and concentrates

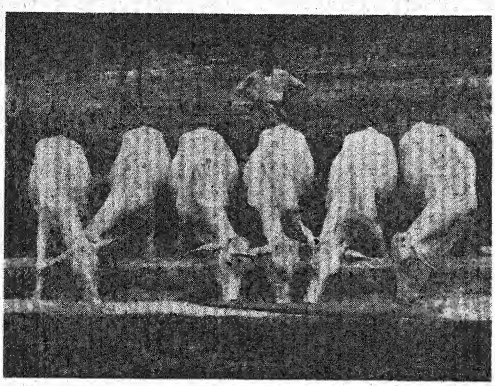

Fig. 4. Heifers of the same age and breed on ' all roughage ' otherwise adequate ration (compare the size of these animals with those shown in Fig. 3)

'roughage group' most of the heifers did not come to oestrum at all even ge of 5-6 years. Only 3 heifers out of 8 came to heat at the age of 3 years. ecame pregnant; the other 6 animals were examined per rectum and it was d that the genital organs were under-developed.

With a view to eliminate the genetical factors the heifers were grouped according to sires. It was found that the heifers from the same sire showed their first oestrum at a younger age in the concentrate group than those in the roughage group.

Discussion

The longer the animal is unproductive, the greater is the liability of the farmer, and from this point of view early calvings are advantageous. Early calvers gave more calves than late calvers [Johansson 1950]. Hartmann [1953] found that fertility and lifetime production were highest in cows which had their first calving at an early age and that it did not affect the body size or growth of the animals. It is the lactation that taxes the heifer and not the burden of pregnancy. The wastage rate, calculated up to the 5th lactation by the Milk Marketing Board [1953] has not been affected by the age at first calving. Gethin [1950] thinks that the information about the influence of age at first calving on subsequent overall reproductive efficiency is conflicting and on the whole insufficient. However, his observations relate to calvings at the age of 27 months and earlier. How early can heifers be calved without any detriment to future life would depend on the environment where they are kept and on the individual heifer. This question has been considered on the basis of the experience gained during these investigations. It appears that at the Farms all the Hariana heifers should show their first oestrum and conceive at the age between 2 years 6 months to 2 years 9 months. They would, therefore, calve at the age of $3\frac{1}{2}$ years. All heifers which do not come to heat at this age should be regarded as cases of sub-fertility and attention should be paid to them to avoid economic loss at the farms.

Summary

In a fairly comprehensive survey of a large number of dairy farms in U. P., it has been observed that the age at first calving is 1538 ± 65 days (approximately 51 months) in Hariana cattle. The earliest age at which the heifer had its first calving was 895 days (approximately $29\frac{1}{2}$ months). Heifers calving beyond the age of 5 years have been considered as confirmed cases of sub-fertility. The percentage of such sub-fertile cases to the total population was 12·4 per cent.

The breeding bulls used at the farms have not appreciably influenced this character. It is explained by assuming that as no selection for this trait was carried out, the sires studied were of average merit. The procedure to be adopted in selecting animals for this character, which can be done simultaneously with the progeny testing of bulls for milk yield, has been indicated.

It has been observed that feeding of balanced ration in general, is favourable for early maturity. The animals which are fed with a balanced ration consisting of concentrates, a dry and a little of green roughage, mature much earlier than those kept in the same plane of nutrition on all roughage (green berseem and *bhusa*)

otherwise adequate ration. It appears that the deficiency of phosphorus in all roughage ration is the probable cause of delayed maturity in the roughage-fed group. In the usual village practice, concentrates are not incorporated in the dietary of cattle. This may be one of the causes of late calving seen in herds kept under rural conditions.

ACKNOWLEDGMENTS

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THE RELATION OF SOME FACTORS TO THE OCCURRENCE OF POST-PARTUM OESTRUS IN HARIANA CATTLE

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A knowledge regarding the interval elapsing between parturition and the occurrence of first oestrus is of value not only for practical breeder but also for the artificial breeding centres as it helps in efficient and profitable breeding of cattle. This is important in view of the fact that generally a breeder is unaware of the average period when he can expect his cow to be in heat after calving.

The present study was undertaken to investigate if the control over the factors like season, milk yield, age and lactation supposed to influence the period between parturition and first oestrus of cows could be of value in curtailing the interval which may prove of economic importance to a breeder.

Review of Literature

The study of the literature showed that limited work had been conducted on this aspect of oestrus in cattle. Guilbert and Mcdonald [1933] reported that 30 per cent of the beef cows came into heat between 20 and 40 days ; 30 per cent between 40 to 60 days and 40 per cent between 60 and 100 days after calving.

Chapman and Casida [1935] held, that the average interval between parturition and first oestrus in Holstein cattle was 59 days with a standard deviation of 30 days. They concluded that on an average, the period from parturition to first subsequent heat was too long for early conception ; 50 per cent of these periods were less than 61 days in length, 40 per cent were between 61-120 days and the remaining 10 per cent were over 120 days in length.

Herman and Edmondson [1950] in a study of 968 normal parturitions in 347 dairy cows concluded that the average length of the interval from parturition to first oestrus was 57 days with a standard deviation of 28 days.

They reported that there was no relationship between the season of the year, the average daily milk production for the entire lactation and the average daily milk production for the period extending from parturition to first subsequent oestrus. The age of the cow and the lactation number were found to be factors influencing the interval.

Material and Methods

The data used in the study were taken from Hariana herd of cattle a 'dual purpose' breed (milk and draught), bred and raised at the Government Livestock Farm, Hissar from 1946 to 1953. In all 538 parturitions in 271 cows with normal gestation were studied.

Teaser bulls were kept in the herd to detect cows in heat. Doubtful cases, however, were confirmed by rectal palpation and with the aid of vaginal speculum. The days from calving to the occurrence of first oestrus were calculated for each parturition from the properly maintained records. The daily average milk yield was calculated from weekly records for the actual days the cow was in milk. Calves were allowed to suckle their dams except on the recording days, when they were used only to 'let down' the milk. The age of the animal was worked out from the date of birth to date of her first oestrus after calving. The month during which the animal came in heat was considered for studying the seasonal influence.

Results and Discussion

Average interval from parturition to first oestrus : In the study of 538 normal parturitions extending over a period of about 8 years, it was found that the average interval from parturition to first oestrus was 228·0±3·9 days. There was 7·5 per cent of cows (Table 1) that came in heat within 89 days after calving; 22·7 per cent between 90 to 179 days; 31·2 per cent between 180 to 269 days; 28·6 per cent between 270 to 359 days and 10 per cent over 360 days.

The interval was higher in this herd as compared to the results achieved by other workers. This may be due to the fact that in the herd the calves were allowed to suckle their dams during the lactation as already reported by Clapp [1933] who found that the frequency of suckling or handling of teats in milking was the main cause for the increase in the length of the interval from parturition to first heat.

Table I

Average interval between parturition and first oestrus

Interval days	No. of cases	Percentage of parturition
Below 29	2	0·4
30—59	15	2·8
60—89	23	4·3
90—119	27	5·0
120—149	44	8·2
150—179	51	9·5
180—209	46	8·6
210—239	62	11·5
240—269	60	11·1
270—299	55	10·2
300—329	57	10·6
330—359	42	7·8
360—389	34	6·3
390 and above	20	3·7

The data was also analysed to find out if the interval following parturition differed from cow to cow. Five hundred observations of 165 cows having two or more lactations which were used for this purpose indicated that the difference was signincant (Table II).

TABLE II

The effect of the cow on the interval from parturition to first oestrus

Source of variation	D. F.	Mean S.	F.
Between cows	164	14896·9	1·69**
Within cows	335	8808·7	..
TOTAL	499	..	..

**Significant at 1 per cent level.

Seasonal influence : The influence of the month of the year on the period following parturition and the occurrence of the first oestrus (Table III) indicated that the average number of days was more for the months of January to April and less for the month of June. The distribution of the cases indicated that the number of cows coming in heat were more during the months of March, April and May and less during the period from July to October.

The effect of the month of the year on the interval was significant as determined by analysis of variance (Table IV). Months when combined into different seasons of the year were found to have a significant effect on the interval from parturition to first oestrus (Table V). The results presented in bar notation are as follows :

Season	Summer	Autumn	Winter	Spring
Average interval from parturition to 1st oestrus (days)	219·8	222·9	234·4	255·7

TABLE III

The effect of month on the length of time from parturition to first oestrus

Months	No. Observed	Percentage of total	Average interval from parturition to first oestrus (days)
January	49	9·1	256·3±11·7
February	37	6·9	249·0±14·1
March	65	12·1	266·8±11·4
April	65	12·1	248·4±13·0
May	66	12·3	236·0±12·5
June	49	9·1	196·2±13·5
July	29	5·4	222·4±17·1
August	29	5·4	230·6±17·3
September	33	6·1	214·6±14·4
October	27	5·0	222·9±17·2
November	39	7·2	211·2±13·1
December	50	9·3	231·1±12·0

TABLE IV

The effect of month on the length of time from parturition to first oestrus

Source of variation	D. F.	Mean S.	F.
Between months	11	20572·62	2·41**
Within months	526	8532·89	..
TOTAL	537	..	..

**Significant at 1 per cent level.

TABLE V

The effect of season of occurrence of first oestrus on the length of time from parturition to first oestrus after partioning the various components of variation

Source of variation	D. F.	M. S.	F.
Between seasons	3	39904·79	4·68**
Between months within seasons	8	13323·06	1·56
Within months within seasons	526	8532·89	..
TOTAL	537	..	..

**Significant at 1 per cent level.

The effect of the season of calving on the interval (Table VI) indicated that the average number of days was higher for the months of April and May and less for the month of September. The effect of different months of calving (Table VII) and the seasons of the year (Table VIII) were found to have a significant effect on the interval from parturition to first oestrus. The results presented in bar notation are as follows :

Season	Winter	Autumn	Spring	Summer
Average length of period from parturition to first oestrus (days)	207·4	207·5	253·0	253·3

TABLE VI

The effect of month of calving on the interval from parturition to first oestrus

Months	No. observed	Percentage of total	Average interval from parturition to first oestrus (days)
January	56	10·4	202·9±12·4
February	56	10·4	247·1±13·4
March	69	12·8	240·9±11·8
April	62	11·5	271·8±11·6
May	38	7·1	263·1±14·1
June	47	8·7	251·9±12·8
July	48	8·9	252·4±12·3
August	39	7·3	217·6±15·3
September	39	7·3	197·0±13·9
October	25	4·6	208·0±15·8
November	24	4·5	201·5±15·6
December	35	6·5	218·5±14·7

TABLE VII

The effect of month of calving on the length of time from parturition to first oestrus

Source of variation	D. F.	Mean S.	F.
Between months	11	30296·52	3·64**
Within months	526	8329·54	..
TOTAL	537	..	..

**Significant at 1 per cent level.

TABLE VIII

The effect of season of calving on the length of time from parturition to first oestrus after partioning the various components of variation

Source of variation	D. F.	Mean S.	F.
Between seasons	3	93780·61	11·26**
Between months within season	8	6489·98	0·78
Within months within seasons	526	8329·54	..
TOTAL	537	..	..

**Significant at 1 per cent level.

The influence of milk yield

The average daily milk production for the entire lactation was studied (Table IX) to see if high milk production had any effect in delaying the first oestrus period following calving. No definite trend was observed in the average milk yields for different intervals from parturition to first oestrus. It seemed that the periods from 30 to 59 and 300 to 329 days showing higher level of production than the other periods was due to chance. There appeared no correlation between the average daily milk yield and the appearance of the first oestrus and as such did not support the common belief that the first oestrus occurs later in high yielding-cows than in the poor producers. These findings were similar to the results obtained by Herman and Edmondson [1950].

TABLE IX

Influence of average daily milk yield per lactation on the length of time from parturition to first oestrus

Interval (days)	No. of cases	Percentage of total parturition	Average daily milk yield (lb.)
Below 3	2	0·4	2·6±2·20
30—59	15	2·8	7·1±1·61
60—89	23	4·3	5·7±1·04
90—119	28	5·2	5·9±0·51
120—149	44	8·2	6·3±0·70
150—179	51	9·5	6·4±0·70
180—209	46	8·5	6·2±0·84
210—239	63	11·7	5·4±1·02
240—269	59	11·0	5·9±0·82
270—299	55	10·2	5·6±1·02
300—329	56	10·4	6·5±0·68
330—359	42	7·8	5·9±0·80
360—389	34	6·3	5·2±1·38
390 and above	20	3·7	5·0±0·77

The influence of age : It was observed (Table X) that the interval for cow between 5-6 years of age was around 270 days, thereafter the interval dropped between 6 to 12 years of age. Cows from 12 years of age and onwards had a higher interval.

The interval of about 417 days between the ages of 4-5 years showed an exception to this trend.

TABLE X

The influence of age on the interval from parturition to first oestrus

Age (months)	No. observed	Percentage of total	Average interval from parturition to first oestrus (days)
Below 47	1	0·2	291·0
48—59	47	8·7	173·5±13·2
60—71	100	18·6	269·8± 9·0
72—83	118	21·9	245·5±8·3
84—95	84	15·6	204·6± 9·8
96—107	62	11·6	232·0±11·4
108—119	48	8·9	238·1±13·0
120—131	36	6·7	230·5±15·0
132—143	24	4·5	237·2±18·4
144—155	11	2·1	280·5±27·2
156—167	5	0·9	270·2±36·6
168 and above	2	0·4	330·0±55·0
TOTAL	538		

One cow below 4 years and two above 14 years were excluded from the study of analysis of variance. The analysis of variance (Table XI) showed that the age had a significant influence on the interval from parturition to first oestrus in cattle.

TABLE XI

The effect of age on the length of time from parturition to first oestrus

Source of variation	D. F.	Mean S.	F.
Between ages	9	46710·90	5·75**
Within ages	525	8127·44	..
TOTAL	534	..	..

**Significant at 1 per cent level.

The influence of lactation number : The data (Table XII) showed that the first calved heifers had higher interval and afterwards with the increase in the number of lactations there was a definite trend towards a shorter interval up to the fifth

lactation and then an increase was observed in the succeeding lactation. The sudden fall for the 7th lactation and particularly for the 8th lactation and above was found to be affected by a regular breeding cow which came in heat after 41, 114, 204 and 139 days during her 7th, 8th, 9th and 10th lactations respectively.

TABLE XII

The influence of lactation number on the length of time from parturition to first oestrus

Lactation No.	No. of cases	Percentage of total cases	Average interval from parturition to first oestrus (days)
1st	146	27·1	264·3± 7·6
2nd	135	25·1	236·7± 7·9
3rd	103	19·2	223·3± 9·1
4th	74	13·8	218·6±10·7
5th	47	8·7	203·7±13·4
6th	17	3·2	231·9±22·4
7th	11	2·0	204·8±27·8
8th and above	5	0·9	196·0±30·8
TOTAL	538	..	..

Analysis of variance (Table XIII) showed that there was significant difference for the intervals between the various lactations. Analysis was limited to the 7th lactation as there were five cases of the lactation ; No. 8 and above and three out of these belonged to a single cow.

The results obtained followed almost a similar pattern to that observed by Hermon and Edmondson [1950]. These findings indicated that the number of the lactation in cattle was closely associated with her age and that both of these factors had a similar effect on the interval from parturition to first oestrus.

It may be concluded that the reproductive efficiency of the cow is at the prime between the 3rd and 5th lactations and from 7 to 12 years of age.

TABLE XIII

The effect of lactation number on the interval from parturition to first oestrus

Source of variation	D. F.	Mean S.	F.
Between lactations	6	35967·98	4·23**
Within lactations	526	8502·26	..
TOTAL	532		

**Significant at 1 per cent level.

SUMMARY

A study of 538 parturitions in 271 Hariana cows of the experimental herd at the Government Livestock Farm, Hissar showed that:

The average length of interval from parturition to the first oestrus was found to be 228·0±3·9 days.

The months and season of the year seemed to affect the length of the post-partum interval to first oestrus. The season of calving also affected the interval.

There appeared no relationship between the average daily milk yield and the interval between calving and first oestrus.

The age of the cow and lactation number were observed to influence the interval from calving to first oestrus.

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LONGEVITY AND RE-PRODUCTIVITY IN HARIANA CATTLE

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(With 1 Text Figure)

INFORMATION in regard to the life span and fertility of different breeds of cattles is of importance to a breeder in the selection of the breed. It assists him in estimating the breeding efficiency of the herd and facilitates in raising a profitable herd by treating heifers that have not bred at the average age of first conception and by culling the stock which is below the standard or has passed the useful breeding age.

The present study was undertaken in the Hariana cattle, a famous general utility breed of the country, capable of providing first quality plough bullocks as well as fairly good milkers.

Review of Literature

Smith and Robinson[6] reported that the average age of the dams of the three beef breeds (Angus, Short-horn, and Hereford) was $6{\cdot}02 \pm 0{\cdot}05$ years at the time of calving. Lacy[3] found that the average age of dams of registered Hereford calves was $5{\cdot}48 \pm 0{\cdot}06$. Only 19·7 per cent of the dams were less than 3 years of age at the time of first service while percentage of dams less than 3 years of age was observed to be higher in the dairy breeds (Holstein 33·5 per cent, Jersey 35·8 per cent, Guernsey 37·5 per cent and Brownswiss 34·6 per cent) than in Herefords. Plum and Lush[4] studied the data of Iowa Cow Testing Associations and found that the mean age at first calving varied from about 25·5 months for Jersey and Guernsey cows to almost 35 months for Red Polled cows. Asdell[1] stated that the average life span of cattle (Bos taurus) from conception was 225 months. Sharma, Vali and Suri[5] on 182 cases found that the average age at first calving of the experimental Hariana herd at Hissar was $1618{\cdot}18 \pm 10{\cdot}53$ days. Einsiedl[2] observed the average age of Pinzgan herd book cows was approximately 9 years and the average number of calves was 5·92. Food and Agricultural Organisation publication[7] revealed that the average age at first calving of the milch breeds, Red Sindhi and Sahiwal, was 41 and 33 months respectively while Tharparkar, Gir and Kangayan, the general utility breeds, had 47·2,2·5, 51·0 and 39·0 months respectively. The average number of calvings during life time varied from 5 to 8 in the different breeds. The active breeding life of bulls for the milch breeds was about 7 years whereas for general utility breeds it was about 10 years.

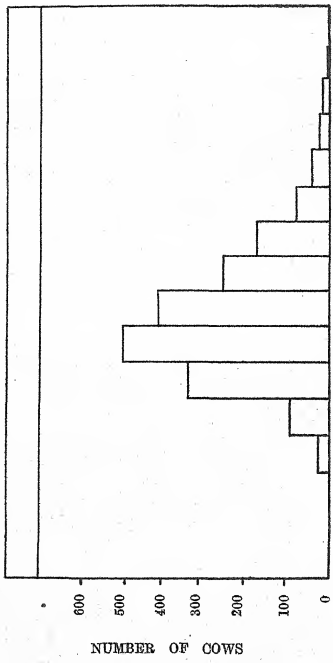

FIG. 1. Distribution of the ages of Hariana heifers at first calving

Material and Methods

The data used in the study were taken from Hariana herd of cattle, bred and reared under semi-ranch conditions at Government Livestock Farm, Hissar, from 1924 to 1938 for cows and from 1925 to 1942 for bulls. The study was based on 1917 normal records of cows and 28 stud bulls maintained at the Farm. The data was purposely confined to this period with a view to study the span of life and reproductive period of the animals that were born during this period and died after having had their normal life. The study beyond 1938 could not be included as most of the animals born were yet alive.

The main herd, to a larger extent, depended on natural grazing for a considerable part of the year. Stall feeding was only resorted to, when grazing became scanty and the stock began to show signs of losing condition. In the case of milch stock the grazing was supplemented by the concentrates according to the milk yields. The cattle, generally, for the most part of the year remained in the open, thorny enclosures except during severe winter nights. Young bulls were given a grain ration for a month or 6 weeks when they were ready for nose-ringing and again for a month or more at the age of 2½ years when they were ready to be issued in the state for breeding. Systematic prophylactic measures were adopted to check the incidence of contagious diseases like rinderpest, haemorrhagic septicaemia and black-quarter.

The reproductive period of the cows was worked out from the first calving date to the end of the last lactation. The life span was calculated from birth to the date of death of the animal. Period of 15 days and above was taken as a complete month while calculating the age.

Results and Discussions

Age at first calving. The age distribution of Hariana cows freshening for the first time (Fig. 1) showed that it was extremely skew. The mode was at 50 months and the mean was $58{\cdot}83 \pm 0{\cdot}20$.

The higher value of the mean was due to positive skewness of the distribution. The age, before which half of the heifers freshened, was near about 55 months. Only 22 per cent of the dams were less than 4 years of age at the time of first calving which was almost similar to the results obtained by Lacy[3] in Hereford cattle. The mean value differed from that of Sharma *et al.*[5] as their study was confined to a limited number of cases extending over a shorter period.

Reproductive life. The average reproductive life of a co[illegible] the herd was $76{\cdot}88 \pm 0{\cdot}92$ months. It was observed (Table I) that the maxi[illegible] percentage of cows remained fertile for 9 years, one month from the date of fi[illegible]lving.

TABLE I

Reproductive life in the Hariana herd

Period after first calving (months)	No. of cases	Percentage of cows reproducing after first calving	Age after first calving (months)	No. of cases	Percentage of cows reproducing after first calving
Up to 19	265	13·82	95—109	295	15·39
20—34	114	5·95	110—124	270	14·08
35—49	182	9·49	125—139	154	8·03
50—64	178	9·28	140—154	48	2·51
65—79	161	8·40	155—169	5	0·26
80—94	239	12·47	170 & above	6	0·32

Calvings during life period. The average number of calves dropped during life time of a cow in the herd (Table II) was $4{\cdot}67 \pm 0{\cdot}11$. The average number of calvings was observed to be less than that of Tharparkar ($5{\cdot}85 \pm 0{\cdot}25$), a similar general utility breed.

TABLE II

Number of calvings in the Hariana herd

Number of calvings	No. of cows	Percentage of cows	No. of calvings	No. of cows	Percentage of cows
1	170	8·87	7	252	13·14
2	211	11·01	8	137	7·15
3	268	13·98	9	36	1·88
4	244	12·73	10	8	0·41
5	254	13·25	11	5	0·26
6	331	17·26	12	1	0·05

Life span of cattle. The average age at death of the cow and bull in the Hariana herd was found to be $136{\cdot}3 \pm 0{\cdot}95$ and $98{\cdot}1 \pm 4{\cdot}6$ months respectively. The maximum age recorded for the cow was 18 years 9 months and 7 days whereas the bull lived for 15 years 9 months and 21 days. It may, however, be stated that the results obtained for the bulls were based on a smaller number of cases and hence no reliable comparison could be made for the age at death of the cow and the bull.

Sex ratio. It was observed from the study of 1917 cows that there were 4,498 male and 4,469 female calves. The overall sex ratio (number of male for every 100 females) was calculated to be 100·4 per cent.

TABLE III

Causes of mortality in different ages of Hariana cattle

(Age in years)

Causes for death	3	4	5	6	7	8	9	10	11	12	13	14	15	16 and above	Total	Mortality %
Tuberculosis	—	2	4	19	30	20	24	21	19	24	25	41	36	25	290	21·85
Kherwan disease*	—	1	—	2	—	4	2	1	—	—	5	2	1	—	18	1·36
Rinderpest	—	1	6	3	2	2	1	—	—	—	—	—	—	—	15	1·13
Haemorrhagic septicaemia	—	1	—	—	—	—	—	—	—	—	—	—	—	—	2	0·15
Black Quarter	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	0·08
Metritis	8	6	5	4	11	12	9	4	5	7	9	5	—	1	86	6·48
Respiratory diseases	—	7	13	8	26	9	8	16	6	9	11	4	4	2	123	9·27
Traumatic pericarditis	1	8	21	17	31	33	32	36	16	16	18	3	3	1	236	17·78
Old age and debility	—	—	—	—	—	—	—	1	6	6	16	22	24	10	85	6·41
Miscellaneous diseases	16	33	38	33	81	58	42	49	35	35	20	20	4	7	471	35·49
Total	25	59	87	86	182	138	118	128	87	97	105	97	72	46	1327	—
Mortality percentage	1·88	4·45	6·56	6·48	13·72	10·40	8·89	9·65	6·56	7·30	7·91	7·30	5·43	3·47	—	—

*An obscure disease.

The incidence of twinning was found to be 0·09 per cent which is in agreement with the findings of Bhattacharya *et al.* who studied 1,892 calvings of the Hariana herd as reported in the publication of Food and Agricultural Organisation[7].

Causes of mortality. The diseases responsible for the death of the cattle coul d only be ascertained for 1327 cases. It was seen (Table III) that the single disease responsible for the heaviest toll of life was tuberculosis. The mortality from this disease was fairly high from 6 years onward and was highest in the older stock. It may probably be due to the fact that no systematic testing of the herd against this disease was adopted before the year 1940 with the result that the diseased animals were allowed to live with the healthy stock which resulted in the spread of the infection. The lowering of vitality of the animals with the advancement in age might be a reason for a higher mortality amongst older stock. Traumatic percicarditis was another cause of high mortality. It affected largely the cattle of ages 7 to 10 years. Although no definite reason could be given for the high mortality of the cows for these ages it was obvious that careless feeding of the stock with the stacked hay containing pieces of loose wire, nails, etc. resulted in the death of the animals. Similar high mortality for these ages was also observed for other non-contagious diseases. The mortality from the contagious diseases was minimum due to the timely adopted prophylactic measures.

Summary

A study of the ages of 1917 Hariana cows and 28 Hariana stud bulls, extending over a period of 15 years and 18 years respectively, showed that :

1. The mean age at which the cow first freshened was found to be $58{\cdot}83 \pm 0{\cdot}20$ months.
2. The average reproductive life of a cow was $76{\cdot}88 \pm 0{\cdot}92$ months.
3. The average number of calvings during the life time of a cow was $4{\cdot}67 \pm 0{\cdot}11$.
4. The average life of the cow was $136{\cdot}30 \pm 0{\cdot}95$ months and that of the bull was $98{\cdot}1 \pm 4{\cdot}6$. The maximum age recorded for the cow and the breeding bull was 18 years 9 months 7 days and 15 years 9 months 21 days respectively.
5. The highest mortality in the herd was due to tuberculosis and most of the cattle between the ages 7 to 10 years died of other non-contagious diseases.

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A HIGH PROTEIN VERSUS A NORMAL PROTEIN RATI ON FOR EGG PRODUCTION IN POULTRY

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In most of the important egg producing countries, protein feeds are costlier than cereal grains. Much work has, therefore, been done in this direction with a view to developing economical rations for poultry which may have less amount of costly protein feed. However, same price relationship does not exist in many areas of India. In some areas the cost of protein concentrates such as groundnut cake is less than the cost of cereal grains.

Jull [1938], Heuser [1946], Winter and Funk [1947], Bird [1948], and Romanoff and Romanoff [1949] have reported that when feeding an all mash ration to laying hens, it should contain approximately 16 per cent protein as the optimum amount.

Vernon *et al.* [1942] found that from an economic standpoint the all mash ration for laying hens should contain not more than 16 per cent protein although an 18 to 20 per cent protein ration produced a few more eggs. This work was carried out in an area where protein feeds are more costly than cereal grains.

Ewing [1951] reported that increasing the percentage of protein in the diet of laying hens within limits of 11·2 per cent and 23·6 per cent, increased egg production, egg weight and body weight. He also stated that when from 62 to 94 per cent of an all animal protein supplement was replaced with peanut meal (groundnut cake) there was no reduction in egg production, hatchability or livability.

The economic relationship between groundnut cake and cereal grains favours the use of a higher percentage of groundnut cake and less grain in poultry rations. It was considered desirable to determine the effects upon egg production and feed consumption of a ration containing 30 per cent total protein with groundnut cake making up 54 per cent of the total ration, as compared with a normal ration.

Experimental

Fifty-eight White Leghorn pullets about five months of age, hatched at the same time and raised on the Agricultural Institute farm, were randomly divided into two groups. The groups were assigned by chance to one of the two adjacent

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pens of equal size and type in which no hens had been kept previously. The groups were assigned by chance to the high protein or normal ration (Table I). Both groups were fed *ad libitum*.

A small amount of greens was given to each group daily.

Weights of individual birds were recorded at the beginning and each month thereafter until the end of the experiment.

The total amount of feed consumed by each group was recorded monthly.

TABLE I

Composition of rations used

Ingredients	No. I (High protein)	No. II (Normal protein)
Ground yellow maize	10 per cent	38 per cent
Wheat bran	15 per cent	15 per cent
Groundnut cake (decorticated)	54 per cent	26 per cent
Gram	10 per cent	10 per cent
Fish meal	5 per cent	5 per cent
Oyster shell	3 per cent	3 per cent
Mineral mixture*	3 per cent	3 per cent
Total protein (N × 6·25)	30·31 per cent	21·73 per cent
Average cost per 100 pounds	Rs. 8/11/6	Rs. 9/15/6

* Containing 50 per cent salt, 50 per cent sterilized bone meal plus 0·05 per cent potassium iodide.

Daily production of eggs was recorded for each group. The experimental period was from September 10, 1955 to April 10, 1956.

At Allahabad this is the cooler period of the year.

RESULTS AND DISCUSSIONS

The total numbers of eggs produced daily by each group from the date of first egg until completion of the project are shown in Table II. The group of pullets on the normal protein ration produced the first egg on October 13 and the group on the high protein ration produced the first egg on October 20. During the month of October ten hens on the normal protein ration produced at least one egg while only eight hens on the high protein ration produced at least one egg during the month.

TABLE II

Total eggs produced daily by two groups of White Leghorn hens from October 13, 1955 to April 9, 1956

(Started with 29 birds in each group and ended with 26 birds in each group)

Date	Protein		Date	Protein		Date	Protein		Date	Protein	
	Normal	High		Normal	High		Normal	High		Normal	High
Oct. 13	2	0	Nov 15	9	9	Dec. 18	4	14	Jan. 20	9	17
.. 14	1	0	.. 16	11	10	.. 19	5	9	.. 21	9	13
.. 15	0	0	.. 17	9	12	.. 20	6	9	.. 22	16	15
.. 16	1	0	.. 18	8	8	.. 21	5	12	.. 23	14	15
.. 17	0	0	.. 19	6	12	.. 22	3	4	.. 24	11	16
.. 18	2	0	.. 20	7	10	.. 23	2	8	.. 25	14	15
.. 19	3	0	.. 21	9	12	.. 24	0	7	.. 26	9	14
.. 20	2	1	.. 22	7	13	.. 25	1	10	.. 27	9	13
.. 21	3	0	.. 23	11	10	.. 26	0	11	.. 28	12	20
.. 22	4	1	.. 24	9	12	.. 27	2	7	.. 29	12	13
.. 23	3	1	.. 25	7	13	.. 28	0	12	.. 30	13	17
.. 24	2	2	.. 26	12	10	.. 29	1	13	.. 31	8	14
.. 25	5	3	.. 27	7	12	.. 30	0	10	Feb. 1	16	14
.. 26	4	3	.. 28	4	11	.. 31	2	11	.. 2	11	19
.. 27	5	4	.. 29	10	12	Jan. 1	4	15	.. 3	13	14
.. 28	4	3	.. 30	9	11	.. 2	6	12	.. 4	15	16
.. 29	4	3	Dec. 1	6	12	.. 3	6	11	.. 5	12	18
.. 30	5	7	.. 2	0	8	.. 4	9	17	.. 6	10	15
.. 31	7	2	.. 3	10	15	.. 5	13	15	.. 7	13	21
Nov. 1	5	4	.. 4	10	11	.. 6	8	10	.. 8	13	9
.. 2	9	7	.. 5	11	13	.. 7	11	14	.. 9	9	20
.. 3	7	7	.. 6	12	15	.. 8	13	17	.. 10	11	15
.. 4	8	7	.. 7	12	11	.. 9	6	13	.. 11	13	17
.. 5	10	6	.. 8	7	12	.. 10	13	13	.. 12	17	17
.. 6	7	9	.. 9	11	17	.. 11	8	17	.. 13	12	17
.. 7	7	10	.. 10	4	11	.. 12	11	10	.. 14	10	17
.. 8	11	8	.. 11	7	13	.. 13	6	8	.. 15	16	20
.. 9	5	10	.. 12	2	10	.. 14	8	11	.. 16	16	17
.. 10	9	10	.. 13	4	8	.. 15	6	10	.. 17	9	22
.. 11	7	12	.. 14	2	8	.. 16	11	10	.. 18	12	15
.. 12	8	7	.. 15	5	11	.. 17	8	15	.. 19	15	19
.. 13	9	13	.. 16	3	9	.. 18	6	10	.. 20	15	14
.. 14	11	11	.. 17	4	6	.. 19	13	12	.. 21	13	20

TABLE II—(*contd.*)

Total eggs produced daily by two groups of White Leghorn hens from October 13, 1955 to April 9, 1956

Date	Protein		Date	Protein		Date	Protein		Date	Protein	
	Normal	High		Normal	High		Normal	High		Normal	High
Feb. 22	15	17	Mar. 7	17	19	Mar. 21	11	13	Apr. 4	7	16
.. 23	14	16	.. 8	16	21	.. 22	19	13	.. 5	7	13
.. 24	15	15	.. 9	14	19	.. 23	5	13	.. 6	8	11
.. 25	11	15	.. 10	10	20	.. 24	16	12	.. 7	8	11
.. 26	19	19	.. 11	16	16	.. 25	16	18	.. 8	9	14
.. 27	14	17	.. 12	14	19	.. 26	9	13	.. 9	9	22
.. 28	17	17	.. 13	14	17	.. 27	13	16			
.. 29	14	13	.. 14	16	16	.. 28	10	11	Total	1636	2199
Mar. 1	18	22	.. 15	10	16	.. 29	14	17	Average Daily	9·1	12·2
.. 2	16	17	.. 16	18	16	.. 30	8	15			
.. 3	13	16	.. 17	14	18	.. 31	7	15			
.. 4	14	16	.. 18	14	16	Apr. 1	10	12			
.. 5	17	21	.. 19	13	15	.. 2	7	13			
.. 6	9	13	.. 20	16	17	.. 3	8	14			

The average daily production of the hens on the high protein ration was 12·2 eggs and of those on the normal protein ration 9·1 eggs daily for the 180 days from the time, the first egg was gathered to the completion of the experiment. The difference is highly significant statistically.

Analysis of variance of daily egg production of two groups of White Leghorn hens

Source of Variation	dF	Sum of Squares	Mean Square
Treatment	1	880·5	880·5**
Days	179	7,424·1	41·5
Error	179	1,450·0	8·1

**=Highly Significant.

Because of a mild infestation with intestinal roundworms the hens in both groups were treated with carbon tetrachloride on December 20, 1955.

There was no significant difference in body weight at each of the monthly weighings between the two groups of hens (Table III).

TABLE III

Average body weight of White Leghorn hens at monthly intervals from September 10, 1955 to April 10, 1956

Ration	Weight on indicated dates (lb.)							
	Sept. 10	Oct. 10	Nov. 10	Dec. 10	Jan. 10	Feb. 10	Mch. 10	Apr. 10
High protein	2·42	2·78	3·45	3·63	3·70	3·93	3·94	3·80
Normal protein	2·45	2·88	3·33	3·50	3·82	3·98	3·68	3·53

There was no significant difference in the amount of feed consumed by the two groups of hens (Table IV).

TABLE IV

Total amount of feed consumed monthly from September 10, 1955 to April 10, 1956 by two groups of White Leghorn hens

Date	Ration	
	High protein (lb.)	Normal portein (lb.)
September 10 to October 10	190·5	180·0
October 10 to November 10	207·0	180·0
November 10 to December 10	245·0	206·0
December 10 to January 10	225·0	248·0
January 10 to February 10	260·0	258·0
February 10 to March 10	230·0	228·0
March 10 to April 10	219·0	233·0
Total feed	1576·5	1533·0

The amount of feed consumed per dozen eggs produced during the seven months period of the experiment was 8·59 pounds on the high protein ration and 11·13 pounds on the normal protein ration. With the high protein ration costing Rs. 8/11/6 per hundred pounds and the normal protein ration costing Rs. 9/15/6 per hundred pounds

the total feed cost per dozen eggs produced was twelve annas for the high protein and Rs. 1/1/9 per dozen for the normal protein rations, respectively.

The mortality rate was the same in each group. Three hens died from each group. Two of the deaths, one in each group, were accidentally caused during the treatment with carbon tetrachloride.

Summary

One group of twenty-nine White Leghorn pullets was fed on the commonly recommended all-mash ration containing approximately 21 per cent protein while a similar group of twenty-nine was fed on an all-mash ration containing approximately 30 per cent protein for a period of seven months.

There was a highly significant difference in daily egg production in favour of the high protein ration.

The difference in the amount of feed consumed by the two groups was not statistically significant.

The hens on the normal protein ration consumed 11·1 pounds feed per dozen eggs produced and the hens on the high protein ration consumed 8·6 pounds feed per dozen eggs produced during the seven months of the experiment. The cost of feed per dozen eggs produced by the group on the normal protein ration was Rs. 1/1/9 while the group on the high protein ration produced eggs at a feed cost of twelve annas per dozen.

There was no difference in mortality in the two groups.

On the basis of this one trial it appears that under Allahabad conditions, laying hens will do as well and possibly somewhat better on a ration containing more groundnut cake and less maize than on a similarly compounded ration containing less groundnut cake and more maize. The difference in cost of the two rations at Allahabad favours the use of the high protein ration for laying hens.

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THE LIFE HISTORY AND BIOLOGY OF THE REDUVID—*ACANTHASPIS SIVA*—A PREDATOR OF THE INDIAN HONEY BEE—*APIS INDICA* F.

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(With 2 Text figures)

REDUVID bugs are predatory in their habits. Eleven species have been recorded in South India. Of these *Acanthaspis siva* D. (Fig. 2) was noted as a predator of the Indian honey bee—*Apis indica* F. Both the adults and nymphs are found freely lurking around the hives, in crevices or in cracks, in tree trunks near the locations of the nests of the Indian bee. In one instance two adults were found inside the cavity of a tree on which a wild colony of bees was hived at a neighbouring village of Coimbatore. The adults and grown up nymphs pierce the workers with the long snout and suck up the liquid portion. An adult bug under captivity was found to feed on two workers a day. Though this bug is not so serious an enemy of honey bees as the wax moths and predatory wasps, it is also capable of causing great havoc in certain seasons. The study of this bug was, therefore, taken up under the aegis of Bee keeping Scheme sanctioned by the Indian Council of Agricultural Research. Following is the gist of observations made during the course of the three years.

Review of previous work

This was recorded as an enemy of hive bees for the first time by Mahadevan [1951]. The systematic position of the insects is given by Distant [1903].

Seasonal occurrence

A record of the systematic collection of adults and nymphs at Coimbatore during the different months of the year was maintained to get on idea of the seasonal distribution, the number of brood in nature, and the optimum period of occurrence of the insect. Table I shows that a larger number of adults was collected during the months of September, October and November and this indicates that rainy and wet weather are favourable for the activity of adult bugs.

Life history

The egg. Fig. 1(1). The female lays small, spherical, brownish or white eggs singly in crevices on the hive stands or over moist or decaying leaf moulds accumulated in the vicinity. The eggs are about 0·75 mm. in diameter and finely sculptured. An adult female is capable of laying 252 eggs in the course of 169 days, the maximum laying per day being 18.

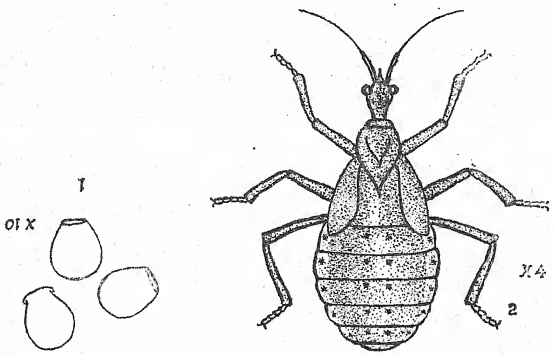

Fig. 1.—(1) Eggs of *Acanthaspis siva*
(2) Nymph of *Acanthaspis siva*

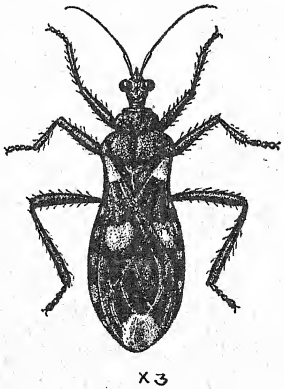

Fig. 2.—*Acanthaspis* siva (adult).

Eggs laid and kept in tubes under laboratory conditions did not hatch. Warmth and treatment with diluted hydrochloric acid failed to hatch them. Moisture is found to be essential for the hatching of these eggs as adults and nymphs were found in larger numbers during the wet seasons of October—December. Hence to simulate the natural environment as in the wet seasons, batches of eggs laid were kept over moist blotting paper or wet sand in petri dishes. The blotting paper and sand were kept moist by continuous wetting as often as required. A few were kept inside the tubes without moisture. In the first case, the eggs hatched out, while those kept in tubes without moisture did not hatch out at all; they got shrunk eventually without hatching.

Egg period. The egg period under laboratory conditions varied from 17—28 days, the shortest being in April, the longest in December. The egg periods noted during the different months are given in Table II. Even under continuous moist conditions variations in egg period were observed in the same batch of eggs. In some instances, the eggs kept in tubes without moistening for over a month began hatching due to subsequent moistening.

The percentage of nymphs to eggs varied widely. During the moist season even a cent per cent hatching was noted; but it should be stated that in the majority of observations, a few eggs laid by the same female on the same day under similar conditions did not hatch at all. The percentage of nymphs to eggs in the different months is noted in Table III.

The nymph. The newly hatched nymphs are pale red and about 2 mm. long with dark eyes and the tip of the abdomen slightly pinkish. The emergence of the nymphs is indicated by the opening of the operculum which is pushed off by the nymph at the time of hatching. Very often the empty egg shell is carried by the nymph on its back. In the course of about six hours, the head, thorax and the leg joints darken a little. Freshly hatched nymphs feed on young caterpillars of *Corcyra cephalonica* in the laboratory. As they grow older they take to workers and drones freely.

Development of the nymph. Fig. 1 (2). There are five instars in the course of the development and emergence as adult. At every successive instar, the eyes, antennea, etc. get well set and the wing pads and appendages increase in size. The casting of the moults takes place by the splitting of the skin from the head region and proceeds backwards. Immediately after moulting, the nymphs remain stationary without feeding. The moulted skins together with the remains of the prey are accumulated and carried on the back of the nymphs probably as a protective measure. In their natural habitats, the nymphs are not easily distinguishable because of their protective colouration and their apparently close resemblance to spiders especially when they are still. While moving, they have got the habit of making jerky movements. The total nymphal period varied from 107—186 days, the details are given in Table IV.

TABLE I

Seasonal occurrence of Acanthaspis siva *in nature*

Year	January		February		March		April		May		June		July		August		September		October		November		December	
	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A	N
1953	2	8		1	1		1				1		1				2		3		2	9	2	
1954	2	1	1	2	3		3	7		3	1		4	3	2		4	2	4	4	5		1	
TOTAL	4	9	1	3	4		4	7		3	2		5	3	2		6	2	7	4	7	9	3	

A—Adults

N Nymphs

TABLE II

Average duration of egg period during different months (in days)

Year	January	February	March	April	May	June	July	August	September	October	November	December
1954	24	21	19	18	20	20	22	23	22	24	25	26

TABLE III

Percentage of nymphs to eggs during the different months

Year	January	February	March	April	May	June	July	August	September	October	November	December
1954	38	48	50	54	15	41	47	56	34	40	100	77

TABLE IV

Nymphal period observed during different parts of the year

Date of hatching	Date of emergence	Nymphal period in days
2-12-1953	11-6-1954	186
24-2-1954	29-7-1954	155
11-4-1954	10-8-1954	121
11-4-1954	30-8-1954	141
11-4-1954	30-8-1954	141
17-4-1954	1-9-1954	137
18-4-1954	3-9-1954	138
20-5-1954	20-9-1954	123
20-5-1954	20-9-1954	123
26-5-1954	10-9-1954	107
26-5-1954	22-9-1954	109

The adult. The female is distinguished by its broad boat shaped abdomen with an obtuse tip divided by a longitudinal slit covered over with a few strong spiny hairs. In the case of the male the abdomen is comparatively slender, pointed and naked without the longitudinal division. The male lives longer than the female, their maximum longevity under laboratary conditions being 202 and 115 days respectively.

The fact that the eggs require wet weather for their hatching and that the duration of the nymphal period is prolonged coupled with the occurrence of large number of young nymphs and adults during October-November in nature, indicates that there is only one brood in a year under natural conditions.

The status of the bug as a bee enemy

The first and second state nymphs require a worker bee a day for their maintenance and the later stage nymphs and the adults consume two workers a day on an average. At this rate a single bug can account for about 650 workers in the course of its life. This only indicates the enormous possibilities of havoc the bug is capable of doing.

But it may be also noted that the extent of damage is considerably reduced because of the high mortality of the nympheal stages especially during the first instar stage and only about 7 per cent of the nymphs hatched reach the adult stage. Besides, as the eggs hatch out only during moist conditions and as there are only very few wet days, in a year, a major proportion of the eggs laid by a female perish without hatching. Thus during normal years, the depletion of the hive population due to this predator is not much.

Control

The predator can however, be kept under check by frequent cleaning of the baseboards. Hive stands and the surroundings of the apiary may also be kept clean and tidy.

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ABSTRACTS

Immunisation against contagious bovine pleuro-pneumonia, with special reference to the use of a dried vaccine. F. W. PRIESTLEY (1955)—*J. comp. Path. & Thera. 65*, 168-182

PRIESTLEY has described the successful use in Sudan of a dried contagious bovine pleuropneumonia vaccine containing 1 per cent agar as an adjuvant. On the basis of his experimental observations he is of the opinion that the Australian method of inoculating a relatively virulent culture into the tip of the tail produces a better immunity response than Bennet's method of using attenuated culture vaccines. According to the author, the disadvantages of culture vaccine in tropical countries are too many. There is a continuous fall in the number of viable organisms resulting in the lowering of its immunogenic property. Besides, the virulence of the organism gets progressively attenuated as the number of subcultures progresses. In order to overcome such drawbacks the author reports the results of trials carried out with vaccines prepared from dried young cultures and puts forth direct evidence that the dried vaccine can be stored for two months without affecting its immunizing properties. He has indirect evidence to show that such a vaccine would retain its immunogenic properties for at least four and a half years. The reconstituted vaccine cannot survive very long and has to be used within two hours.

The observations that dried organisms fail to establish themselves when inoculated into cattle and thus do not set up immunity have been confirmed. In order to overcome this difficulty he incorporated 1 per cent agar as an adjuvant. Eighteen bulls inoculated with 0·2 ml. suspension of dried organisms in a suitable fluid to which 1 per cent of agar had been added were later countered with virulent culture along with a sufficient number of controls. Excepting two vaccinated animals all proved immune while the controls succumbed. Duration of immunity on the basis of a single trial was found to be as long as three years. Detailed description of the maintenance of the 'seed' material and preparation of the vaccine has been given (R. N. S.)

Immunization of chickens against New Castle disease and infectious bronchitis by the spray method. J. F. CRAWLAY—*Proc. Tenth World Poultry Conference (1954)*

LITERATURE regarding immunization of chickens against infectious bronchitis and Newcastle disease has been reviewed.

The currently used vaccine against New Castle disease (N. D.) and infectious bronchitis (I. B.) is a combined one, incorporating a high egg-passaged strain of I. B. (R. 1) and the Blacksburg strain of N. D. (B. 1) of low virulence but high titre. The

vaccine is administered by spraying a fog over the head of baby chicks, confined in chick boxes, any time during the first five days of age if the chicks possess parental immunity, or between the second and fifteenth week if chicks are from non-immunized parents. The success of this method is due to the use of a sprayer which delivers uniform droplets of optimum size, i.e. 3—10 microns in diameter; and the selection of strains for their strength and length of immunity induced. The antibody levels in day-old vaccinated chicks reach their heights in 3 and 6 weeks for N. D. and I. B. respectively and last up to 3 months or more, when a boosting dose of the same vaccine induces life-long immunity without causing reactions. About 1 per cent mortality may be encountered when the vaccination is carried out on a mass scale. Over 10 million chicks have been vaccinated so far in Canada with satisfactory results. The immunity produced in adults is superior to that by the ocular method, and of a comparable level to that stimulated by the wing-web type of vaccine. (S. B. V. R.)

The effect of frequency of ejaculation on the semen production, seminal characteristics and libido of bulls during the first post-puberal year. BAKER, F. N., VADEMARK N. L. and SALISBURY, G. W. (1955)—*J. Dairy Sci.* Vol. 38 No. 9—1000—1005

THE present paper records the results of experiments designed to determine the age at which bulls become sexually mature and the effect of frequency of ejaculation on semen production, seminal characteristics and libido of early post-puberal bulls and the effect on later semen production of the bulls.

Nine Holstein bull calves were divided at random into a groups of three each to be assigned to collection frequencies of one, two and three times per week. All particulars regarding their sexual behaviour up to the time of their response in artificial vagina and thereafter semen characteristics of 50 samples from each collection frequency group were recorded.

The sexual interest was first expressed at an average age of 29·4 $\pm$2·14 weeks. The bull calves showed ability to ejaculate at the mean age of 38·9 $\pm$1·30 weeks. There was no significant effect of frequency of ejaculation on semen volume, per cent motile sperm, sperm concentration, total sperm per ejaculation, per cent atypical sperm and total motile sperm per ejaculation in all frequency groups, while significant differences were found as the bulls aged during a 1-year period after puberty. The libido, however, reduced significantly in the three-times-per-week group as measured by the proportion of failures to mount and ejaculate. (S. G. S.)

Acquired resistance to *Dictyocaulus viviparus*, the Lungworm of cattle. R. RUBIN and J. T. LUCKER—*Cornell Vet. 46* (1), 88-96

THE paper deals with investigations into the phenomenon of acquired resistance of cattle to the lungworm, *Dyctyocaulus viviparus*. The authors conducted a series of experiments with the following objectives: (i) to clarify the factors responsible for retardation or arrest of the development of this parasite in naturallyinfected

cattle reported by previous workers, and (ii) to explore the possibility of developing an adequate and durable acquired resistance to reinfection which might lead to feasible procedures of immunization against the lungworm disease, for which there is no satisfactory drug treatment.

The authors have reported that recovery from an initial lungworm infection conferred a strong resistance to reinfection on nine out of eleven calves or yearlings. These animals were initially infected with 5,000 to 43,000 infective larvae and were subjected to reinfection after they had eliminated their initial infection. No clinical effects occurred in five animals challenged with single dose of 52,000 to 58,000 infective larvae which proved fatal to previously unexposed animals. But severe clinical effects occurred in most of the others whose resistance was challenged with over 200,000 infective larvae, and one animal failed to survive such a challenge infection. Animals whose resistance was repeatedly challenged became highly immune. Administration of as many as 750,000 infective larvae to such animals did not result in the development of a patent infection and had little or no clinical effects. The resistance lasted for at least seven months after recovery from an initial infection. In case of an animal subjected to repeated re-exposures, the resistance lasted for at least eleven months.

As regards factors responsible for this resistance, the authors have been unable to demonstrate directly whether or to what extent resistance prevents ingested larvae from penetrating the gut wall and reaching the circulation or destroys the larvae while in the lymphatic or circulatory system. They have opined that probably the percentage of the larvae administered that reaches the lungs is considerably less in resistant than in susceptible animals. They found that some of the larvae administered reached the lungs of resistant animals, but nearly all the young lungworms usually were eliminated in an immature state within three weeks. (H. C. M.)

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STUDIES ON FOOT-AND-MOUTH DISEASE VACCINATION IN INDIA

II—A CONCENTRATED CRYSTAL VIOLET VACCINE

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[Received for publication on July 22, 1955
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In an earlier paper [Dhanda *et al.*, 1953] experimental trials on foot-and-mouth disease vaccination with crystal violet vaccine containing 2·5 per cent virus have been described. The dose of this vaccine was 30 to 50 cc. given subcutaneously. It was rather an unwieldy dose and difficult to administer in large numbers of animals, hence it was thought necessary to carry out further experimental work to modify the vaccine so as to facilitate its use in large-scale vaccination in the field. Attempts were, therefore, made to prepare a vaccine with a higher percentage of virus content and reduce the volume of vaccine per dose. Since the minimum dose of crystal violet vaccine is 30 cc., the modified concentrated vaccine has six times the virus content (15 per cent), while the dosage of the vaccine is reduced to one-sixth, i.e. 5 cc. for subcutaneous injection.

Material and Method

Preparation of the vaccine

The tongue epithelium with the vesicular fluid collected from hill bulls inoculated artificially in the tongue with the virus is well triturated and suspended in phosphate buffer pH 7·6 and filtered through Seitz filter. The filtrate is mixed with blood collected from virus donors at the height of thermal reaction. Sufficient quantity of buffer is added to bring the concentration of epithelium to 15 per cent. The addition of blood is so regulated that the liquid content of the vaccine consists of half blood and half buffer solution. Crystal violet is then added to give a final concentration of 0·03 per cent of the dye. The vaccine is incubated for 7 days at 37°C. It is tested in cattle before use.

The percentage of virus in the vaccine is based on the quantity of the tongue epithelium that goes into the vaccine. This tissue is very rich in virus. By incorporating blood collected from the virus donors into the vaccine, a certain amount of virus contained in the blood is also added to the vaccine by way of reinforcement. It is known that though its concentration may be variable, virus is present in the blood at the height of thermal reaction. Besides, addition of blood maintains the homogenity of the vaccine.

Experimental vaccination

Small-scale laboratory experiments were conducted using various percentages of virus content to test the value of the vaccine, monovalent type 'O'. The dosage for all brews of vaccine was 5 cc. subcutaneously. Of the various experiments carried out in this connection, two are dealt with in detail; the first one in which the vaccine contained 15 per cent virus and the second with 10 per cent virus. These vaccines were tested in batches of hill bulls and careful observations were made on the reaction following vaccination. This consisted of a slight local swelling lasting for 3 to 4 days, a general rise in the body temperature of about a degree above the normal for a couple of days. Animals continued to feed normally during the period. The nature of reaction in the vaccinated animals was practically the same as seen with the usual dilute vaccine in spite of an increase in the concentration of the virus. Details of the experimental work were recorded in the annual report of the scheme [Gopalakrishnan, 1951].

Immunity test

Immunity test of the two batches of animals was carried out by the administration of live virulent virus type 'O' given intralingually in 4 tracks. The details of the tests are given in Table I. In the batch of 8 animals vaccinated with the concentrated crystal violet vaccine containing 15 per cent virus only, 6 were available for the immunity test, the other two died earlier of other causes. All the six animals were found immune when challenged with virus type 'O', 23 days after vaccination. Five control animals receiving the virus alone, reacted severely while one did not react, probably due to previous natural infection and consequent immunity. In the other batch of 10 animals vaccinated with the concentrated crystal violet vaccine containing 10 per cent virus content and challenged 27 days later, a breakdown of immunity was observed in 4 animals. It was thus concluded that the vaccine containing 10 per cent virus was not very satisfactory. It was, therefore, decided to use a vaccine containing not less than 15 per cent virus for further experimental trials.

Field trial of the vaccine

Since the laboratory tests with the vaccine containing 15 per cent virus were satisfactory, both as regards the post-vaccination reaction mild and transient and the type of immunity which appeared to be adequate, arrangements were made to undertake large scale field trial in an organised farm where facilities were available for periodical observations and recording. The trial was carried out at the Government of India, Cattle-*cum*-Dairy Farm, Karnal. As a practical test under natural field conditions, half of the young stock of age-group between 9 months and 3 years, were taken up for vaccination and about an equal number of the same age-group was kept as unvaccinated healthy controls with the view that if there was a natural outbreak of foot-and-mouth disease it would be easy to assess the value of the vaccine.

A total of 236 animals of the representative breeds on the Farm were vaccinated on February 11, 1953. Bivalent vaccine, type 'O' and 'A' was given to 189 animals and 47

TABLE I

Concentration of epithelial tissue (foot-and-mouth-disease virus) in crystal violet vaccine for establishment of immunity at a flat dose of 5 cc. of the vaccine

Series No.	Concentration used	Hill Bull No.	Reaction to test inoculation	Remarks
I	15 per cent	91		Died of other causes not connected with foot-and-mouth disease before test inoculation
		71	—	Immune
		85	—	do.
		99	—	do.
		83	—	do.
		69	—	do.
		111		Died of other causes not connected with foot-and-mouth disease before test inoculation
		65	—	Immune
Unvaccinated controls to Series No. I		53	+	Susceptible
		10	+	do.
		26	+	do.
		17	+	do.
		27	+	do.
		25	—	Probably immune as a result of previous natural infection
II	10 per cent	142	+	Susceptible
		138	—	Immune
		144	+	Susceptible
		132	—	Immune
		145	—	do.
		139	+	Susceptible
		115	+	do.
		79	—	Immune
		55	—	do.
		23	—	do.
Unvaccinated controls to Series No. II		118	+	Susceptible
		135	+	do.
		133	+	do.
		125	+	do.
		113	+	do.
		86	+	do.

1. The vaccines were monovalent products of foot-and-mouth disease virus Type 'O'. The test inoculations were with the homologous type of virus administered intralingually in 4 tracks, in addition to aphthisation and contact infection.

2. Animals in Series I were tested after an interval of 23 days and those in Series II after an interval of 27 days following vaccination.

3. Vaccines for the two series were made at different times and tested separately with controls for each series.

received polyvalent vaccine prepared from all the three standard strains of the foot-and-mouth-disease virus. The animals were kept under observation for one week following vaccination and the nature of reaction was studied. The reaction was practically of the type as was noted in the hill bulls in the laboratory tests. About a dozen animals showed local swelling that persisted for more than a week. All the animals were feeding normally and well during the period of observation.

Natural outbreak

A natural outbreak of foot-and-mouth disease occurred among the young stock on the Farm at the end of March, 1953. As the disease showed a tendency to spread among the young animals and calves, the Farm authorities aphthised all the young stock to lessen the duration of the outbreak. During the investigation in the latter half of April, 1953, it was observed that the infection was prevalent among the young stock only. The disease had not spread to adults, particularly the cows as they were housed in sheds away from the young stock.

This outbreak afforded an opportunity to assess the value of the vaccination which had been carried out on February 11, 1953. During the course of the outbreak on the Farm, daily observations and careful examination of all the animals was made. It was noticed that of the vaccinated group comprising 236 animals only two calves contracted a mild form of the disease while as many as 210 out of the 400 unvaccinated animals suffered from the disease. Unfortunately, the type of virus responsible for this outbreak could not be determined, as intimation of the occurrence of the disease was received late and the material collected for the isolation of the virus proved non-viable. However, the efficiency of the vaccine in preventing the disease is proved beyond doubt on account of the occurrence of this natural outbreak of the disease only about 2½ months after vaccination.

The second experimental trial of the concentrated crystal violet vaccine, bivalent type 'O' and 'A' was made at the Tisco Farm, Jamshedpur, and animals ranging between the age-group of 9 months to 3 years were taken up for vaccination. Half the total number of the young stock was vaccinated and the other half was kept as healthy controls so that in the event of a natural outbreak of foot-and-mouth disease it would be easy to assess the value of the vaccine. A total number of 117 animals of the representative breeds of cattle—Sindhi, Hariana, Jersey and Murrah buffaloes—on the Farm were vaccinated with 5 cc. each subcutaneously on February 18, 1954. The post-vaccination reaction in the animals was satisfactory.

The first immunity test to find out the degree and duration of immunity was carried out on January 3, 1955 and the second one on September 12, 1955. The results of these tests are presented in Table II.

It will be observed that in both these tests, vaccinated animals under test did not show any reaction. In the first immunity test 3 out of the 4 controls reacted typically showing primary lesions in the mouth and a rise of about 2°F in body temperature. In the second immunity test the reaction to the challenge observed in all the four controls was also typical.

The results of these tests indicate that there was evidence of adequate immunity for a period of 17 months and 25 days or say nearly 18 months following vaccination.

TABLE II

Duration of immunity following vaccination with concentrated crystal violet vaccin bivalent type 'O' and 'A'

Immunity test No.	Animal	Number	Type of virus used for test	Reaction to test inoculation	Remarks
I	Cow calf	443	'O'	—	Immune
	do.	515	do.	—	do.
	Buff calf	392	do.	—	do.
	do.	362	do.	—	do.
	Cow calf	537	'A'	—	do.
	do.	664	do.	—	do.
	Buff calf	374	do.	—	do.
	do.	309	do.	—	do.
Unvaccinated Controls	Cow calf	542	'O'	—	Did not react to test inoculation
	Buff calf	322	do.	+	Susceptible
	Cow calf	564	'A'	+	do.
	Buff calf	304	do.	+	do.
II	Cow calf	554	'O'	—	Immune
	do.	392	do.	—	do.
	Buff calf	310	do.	—	do.
	do.	319	do.	—	do.
	Cow calf	669	'A'	—	do.
	Buff calf	322	do.	—	do.
	do.	7	do.	—	do.
Unvaccinated Controls	Cow calf	677	'O'	+	Susceptible
	Buff calf	360	do.	+	do.
	Cow calf	681	'A'	+	do.
	Buff calf	341	do.	+	do.

1. The concentration of virus of each type was 15 per cent in the vaccine.

2. The test inoculation were made with 1 : 100 suspension of fresh guinea-pig pad virus, administered intradermolingually in 5 tracks, 4 parallel and one across.

3. The first immunity test was carried out on January 3, 1955 at an interval of 10 months and 10 days following vaccination and the second immunity test was carried out on August 12, 1955 at an interval of 17 months and 25 days after vaccination.

SUMMARY

The article deals with the experimental work carried out with the object of modifying the crystal violet vaccine for use in large-scale vaccination in the field. Crystal violet vaccine (2·5 per cent virus content) is used in the dosage of 30 to 50 cc. which is found to be a rather unwieldy dose and difficult to administer in large number of animals.

The method of preparation of the concentrated crystal violet vaccine is similar to that for the preparation of crystal violet vaccine described in an earlier paper, excepting that the concentration of the virus is increased to 15 per cent.

Experimental trials were undertaken with the concentrated crystal violet vaccine with 15 and 10 per cent virus content in a dose of 5 cc. administered subcutaneously.

Indications of adequate immunity were obtained from the test carried out on batches of vaccinated animals at the Institute by administration of live virulent virus.

A large-scale field trial was undertaken with the vaccine at the Karnal Farm where 236 young stock between the ages of 9 months and 3 years were vaccinated and an adequate number of animals of the same age-group were left as unvaccinated controls. Assessment of the value of the vaccine was facilitated in the course of a natural outbreak of the disease which occurred on the Farm about 2½ months later. It was observed that of the 236 animals of the vaccinated group only 2 animals contracted a mild form of the disease while 210 out of the 400 unvaccinated animals suffered from the disease.

The second large-scale field trial was undertaken at the Tisco Farm, Jamshedpur and the results, of the immunity tests indicate that the vaccinated animals had adequate immunity when exposed to artificial infection with live virulent virus after a period of 17 months and 25 days following vaccination.

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STUDIES ON REPRODUCTIVE EFFICIENCY IN DONKEY MARES

By M. L. Kohli and K. R. Suri, Government Livestock Farm, Hissar

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FERTILITY of the mares bred during and after foal heat has been studied by various workers, but very limited information is available about the breeding of donkeys. The present study was undertaken to investigate the reproductive efficiency in donkey mares bred during different periods of the year at various intervals of post-partum oestrus.

Review of Literature

Williams [1926] recorded the results of 120 ninth-day breedings in a famous thorough-bred stud of high repute for fertility. Thirty per cent conceived at the ninth-day breeding ; 40·8 per cent at later matings after having failed at first service and 29·2 per cent failed to settle. Those which conceived on ninth day showed 11·2 per cent of aborts and non-viable foals while the pregnancies from later breedings were followed by 4·1 per cent aborts and non-viables. Caslicks [1937] reported that of 533 mares bred on the ninth or tenth day, 36·6 per cent conceived ; while of those which failed when bred at first post-partum oestrus, 56·6 per cent conceived at second mating. Jennings [1941] stated the rate of conception of one service from ninth day breeding to be 43·7 per cent as compared with 67·3 per cent for those first bred at later dates. An abortion ratio of 12·8 per cent was detected which was four times as great as that followed from first breeding at later dates. The rate of death or diseased foals at birth was 7·3 per cent following ninth day breeding which was six times as great as that from later breedings. The rate of heavy or retained placenta occurred in 29·1 per cent of mares bred on ninth day and only 21·0 per cent in those bred at later periods. Stevenson [1945] noted no significant difference in the percentage of conception or in percentage of healthy foals born to a group of mares bred within 8 to 14 days after parturition and a similar group bred during non-foal heats. Wagenar [1948] concluded that the conception rate is highest in mares when service takes place in later spring (May to June) and that fertility is reduced in the first heat after foaling. Nishikawa and Yamasaki [1949] considered that the breeding season in she-ass to be from April to September ; December and January to be months of sexual rest, while the intervening months represent phases of transition into and from the breeding season. Korolikov [1952] observed the foaling period in mares from March to July ; and that the majority foaled from March to May. Mares foaling from March to May required 2·2 to 2·4 services per conception and 6·4 for those in July. Jordao [1951] found the average conception rate in she-asses to be 57·1 per cent.

Material

The data of 128 donkey mares used in the study were collected from the donkey breeding stud at the Government Livestock Farm, Hissar, for a period of about 38 years (December, 1916 to May, 1954). This stud was maintained at the Farm with the object of supplying donkey stallions to different parts of the Punjab State to promote mule breeding. In all, 694 pregnancies as confirmed by subsequent normal foalings, were studied.

The animals were let out for grazing in the morning and returned to stables in the evening. In the days of scarcity, the grazing was supplemented by 40 lb. of green fodder and 2 lb. of concentrates per animal. Animals for heat were checked regularly, both morning and evening before they had moved out for grazing and after they had returned to the stables. Cases that were detected on heat were given natural service.

Close in-breeding was avoided with the frequent introduction of fresh blood by the purchase and exchange of new donkey stallions from other studs in the State and by the imported American Jacks.

Results

The study was based on 694 actual foalings recorded during a period of about 38 years. For the post-partum foalings it was observed that 2·2 services were required for a donkey mare to conceive.

The percentage of mares that conceived on the first, second, third and fourth service was 46·9, 26·6, 11·4 and 6·9 respectively (Table I). The remaining 7 per cent of the pregnancies took 5 or more services with nearly 3 per cent of these requiring 7 or more services. The results showed a decrease in the efficiency of each subsequent service as the highly fertile donkey mares seemed to have got pregnant with the first or second matings. The breeding efficiency for each of the first five services was 46·9 per cent conception in first service, 50·0 in second, 43·0 in third, 45·3 in fourth and 31·2 for the fifth time.

Table I

Per cent of total number of donkey mares conceiving at each consecutive service after the first foaling

Service sequence	1	2	3	4	5	6	7	8	9	10 and above
Number mated	614	310	135	64	32	16	9	5	3	4
Number of conception	288	155	58	29	10	4	2	1	1	1
Per cent conception	46·9	50·0	43·0	45·3	31·2	25·0	22·2	20·0	33·3	25·0
Percentage of mares receiving 'n' services for conception	46·9	26·6	11·4	6·9	2·6	1·4	1·0	0·7	0·9	0·4
n	1	2	3	4	5	6	7	8	9	10

The percentage of mares that conceived on the first, second, third and fourth service for the first foaling was 55·2, 21·4, 10·3, 8·9 respectively (Table II).

The average number of services required per conception for the first foaling was 1·9 with the average fertility as 52·2 per cent. The average number of services and the fertility per cent for the post-partum foaling was 2·2 and 46·1 respectively. The difference between the services required and the fertility rate for the first foaling period and for the later foalers was not significant.

TABLE II

Per cent of total number of donkey mares conceiving at each consecutive service for the first foaling

Service sequence	1	2	3	4	5	6	7	8	9
Number mated	145	65	34	19	6	4	3	1	1
Number of conception	80	31	15	13	2	1	2	..	1
Per cent conception	55·2	47·7	44·1	68·4	33·3	25·0	66·6	..	100·0
Percentage of mares receiving 'n' services for conception	55·2	21·4	10·3	8·9	1·4	0·7	1·4	..	0·7
n	1	2	3	4	5	6	7	8	9

The length of the post-partum breeding interval and its effects on the reproductive efficiency indicated (Table III) that, on an average, maximum number of donkey mares came in heat within 40 days of foaling and thereafter the number decreased with the increase in the post-partum interval. The shortest inter-foaling period of 494·6±11·6 days fell between the post-partum breeding interval of 40-79 days. The number of services per conception, although lower than 1·9 in a few post-partum breeding intervals did not compare favourably with 1·9 services of 40-79 days interval as the inter-foaling period corresponding to these services was significantly high.

Further analysis of the data indicated that there were 198 cases which were mated within 16 days after foaling. Out of these 48·4 per cent were served below 11 days, 32·4 per cent between 11 to 13 days and 19·2 per cent between 14 to 16 days after foaling and the per cent of fertility was observed to be 27·1, 31·2 and 34·2 respectively. The rate of conception of first service during foal heat period of 10 days' breeding was 27·1 per cent as compared with 50·1 per cent for those bred during non-foal heat. The difference of fertility rate between the two was significant. The inter-foaling period for the additional post-partum days corresponding to each group is given in Table III.

TABLE III

Length of the post-partum breeding interval and its effect on the reproductive efficiency in donkey mares

Post-partum breeding interval	No. of first services	No. of conceptions	No. of total services	Services per conception	Inter-foaling period
0—39	296	649	270	2·4	511·9±12·4
40—79	131	219	115	1·9	494·6±11·6
80—119	62	132	53	2·5	520·4±13·4
120—159	36	63	33	1·9	528·6±12·2
160—199	23	44	23	1·9	559·4±15·3
200—239	16	31	15	2·1	636·1±41·8
240—279	7	7	4	1·8	641·5±15·5
280—319	7	7	4	1·8	648·8±34·8
320—359	5	5	3	1·7	714·0±6·8
360—399	10	12	9	1·3	710·0±19·1
400—439	1	2	1	2·0	789·0± ..
440—479	4	5	4	1·2	850·5±16·7
480—519	3	3	3	1·0	885·7±13·0
520—559	2	2	1	2·0	2093·0± ..
560 and above	11	11	11	1·0	1325·4±104·3
TOTAL	614	1192	549	..	..

It was observed (Table IV) that the foaling percentage throughout the year did not vary from month to month.

TABLE IV

Effect of the month of the year on fertility in the donkey mares

Month	No. of cases served	No. of foalings	Fertility percentage
January	75	37	49·3
February	117	53	45·3
March	88	39	44·3
April	123	54	43·9
May	129	58	45·0
June	128	63	49·2
July	120	51	42·5
August	98	42	42·9
September	91	43	47·2
October	76	39	51·3
November	60	29	48·3
December	87	41	47·1

The maximum post-partum interval for the fertile service was 173·17±21·53 days at fourth foaling and minimum of 129·04±36·20 days at the seventh foaling (Table V). The intervals for the ninth foaling and above were not taken into consideration as the number of cases were few. The average period for fertile service was 162 49±6·67days.

TABLE V

Number of services and the post-partum interval for different foalings in the donkey mares

Sequence of foaling	No. of conception	Service per conception	Per cent services resulting in conception	Average post-partum interval for fertile services (days)
1	122	1·8	55·2+ 0·03	173·91±12·82
2	115	1·9	56·0±0·03	168·79±14·65
3	90	2·1	48·7±0·04	160·51±17·25
4	97	1·9	51·7±0·04	173·17±21·53
5	59	1·7	60·8±0·05	141·97±16·87
6	38	1·8	56·9±0·06	132·82±18 89
7	25	1·6	62·5±0·09	129·04±36·20
8	12	1·7	57·1±0·11	137·83±46·55
9	9	2·2	45·0±0·11	214·22±66·65
10	2	4·0	25·0±0·18	295·00±7·00

Discussion

The results of this study indicated that the average fertility rate of 47·2 per cent differ from the results reported by Jordao [1951] who obtained the average conception rate of 57·1 per cent in his study of 43 she-asses during the year 1939 to 1949. The average number of services required per conception was 2·1 which was lower when compared to the findings of Korolikov [1952] who got 2·2 to 2·4 and 6·4 services per conception for the majority of mares that foaled from March to May and for July respectively. The percentage of conception of donkey mares bred during foal-heat was lower than those bred during non-foal heats which is in agreement with the observations of Williams [1926], Caslicks [1937] and Jennings [1941]. This low fertility rate may possibly be due to the incomplete involution of the uterus during the foal heat period. No period for sexual rest was observed as reported by Nishikawa [1949].

Summary

A study of 694 foalings of 128 donkey mares during the period from 1916 to 1954 showed that :

The services required per conception and the fertility rate for the first foaling did not differ significantly from the post-partum foalings.

A mean of 2·1 services was required per conception and the average fertility rate of the stud was 47·2 per cent.

The conception rate of foal heat was poorer than those bred at later dates. Fertility rate was highest for the period between 40-79 days after foaling.

The foaling percentage did not vary from month to month.

The average post-partum period for fertile service was $162{\cdot}49 \pm 6{\cdot}67$ days.

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COMPARATIVE EFFECT OF A NORMAL AND HIGH-PROTEIN RATION WITH AND WITHOUT "AUROFAC"[1] UPON GROWTH RATE OF CHICKS

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IT is rather generally agreed that the addition of aureomycin and vitamin B_{12} to normal rations or rations with less than the normal amount of protein will increase the growth rate of chicks to eight weeks of age. Berg *et al.* [1950], Scott and Glista [1950], Biely and March [1951], Stockstadt and Jukes [1951], Heuser and Norris [1952] and Macklin *et al.* [1952] reported that aureomycin exerted a definite stimulating effect upon growth when fed to chicks with rations containing normal or below normal amounts of protein. These results were observed outside India. Bose *et al.* [1955] feeding vitamin B_{12} and bacitracin to chicks on a normal ration common in India, obtained increased growth to eight weeks of age. Reed and Velu [1955] feeding aureomycin and vitamin B_{12} with a ration containing 22 per cent total protein obtained a significant increase in growth rate of chicks to six weeks of age. Most of the work reported on the use of antibiotics and vitamin B_{12} was done with rations containing normal or below normal amounts of protein with the main objective to save costly protein supplement.

With the relative prices of maize and groundnut cake in many areas of India favouring the increased use of groundnut cake for cheaper rations, evidence was needed as to the effects upon the growth rate of chicks of a high-protein ration containing a high proportion of groundnut cake. Ewing [1951] in reviewing numerous experiments on the determination of the optimum protein level for chicks, concluded that about 21 per cent is the best during the first twelve weeks but that there was evidence to indicate that higher levels of protein were not injurious and might be beneficial. Also in reporting work of Milne [1932] it was stated that he obtained excellent growth with chicks fed diets containing 22·5 and 30·5 per cent protein during the first six weeks. Biely *et al.* [1952] and Scott *et al.* [1952] reported that aureomycin did not lower the dietary level of protein required by chicks but improved growth more at protein levels below the normal requirement.

[1] Commercial product containing 1·8 grams aureomycin and 1·8 milligrams vitamin B_{12} per pound.

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With the present economic relationship between maize and groundnut cake favouring the use of rations containing higher proportions of groundnut cake than are normally used it was considered desirable to investigate the effects of such a ration upon chicks when fed with and without "Aurofac".

Experimental Procedure

One-hundred-eighty Rhode Island Red day-old chicks, obtained from the Government Poultry Farm, Ganjeria, Lucknow, were randomly divided into 20 groups of nine chicks each. The groups were randomly assigned to wire cages. Brooding heat was provided by sixty watt electric light lamps suspended in each cage. The groups were rotated in a systematic order from one cage to another each week in order to eliminate possible position advantage. Feed and water were supplied *ad libitum*. Feed remaining each day was weighed back and not offered again. Records of weekly weight, mortality and feed consumption were kept. Weight of individual chicks was recorded at the beginning and close of the project.

Ten groups of chicks chosen randomly were given diet No. 1 and the other ten groups were given diet No. 2 as shown in Table I. Five groups on diet No. 1 and five groups on diet No. 2 chosen randomly, received the basal diets plus 9 grams aureomycin and 9 milligrams vitamin B_{12} per ton of ration (Aurofac at rate of 5 pounds per ton).

Table I

Composition of basal diets : Trial No. 1

Ingredients	Diet	
	No. 1	No. 2
Ground yellow maize	44 per cent	20 per cent
Wheat bran	10 per cent	10 per cent
Groundnut cake	36 per cent	60 per cent
Fishmeal	5 per cent	5 per cent
Sterilised bonemeal	2 per cent	2 per cent
Lucerne leaf meal	1 per cent	1 per cent
Limestone	1 per cent	1 per cent
Salt	0·5 per cent	0·5 per cent
Shark-liver oil	0·5 per cent	0·5 per cent
Manganese sulfate	5 oz. per ton	5 oz. per ton
Dried skim milk [1]	4 lb. per hundred	4 lb. per hundred
Total protein (N.×6·25) [2]	22·37 per cent	30·56 per cent
Average cost per 100 pounds	Rs.13/2/6	Rs.12/1/0

[1] From the fourth to seventh week, dried skim milk was added to all diets at the rate of 4 pounds per 100 pounds of ration.

[2] Determination made by Chemistry Department, Allahabad Agricultural Institute.

Early in the third week a few chicks began to show symptoms of curled toe paralysis. The first to be affected were in the groups receiving "high-protein" with Aurofac. Within two days some chicks in groups on rations without Aurofac showed similar symptoms. The most rapid growing chicks were the first to show signs of deficiency. Re-examination of our basic ration showed a possible deficiency of riboflavin. To correct the deficiency, dried skim milk was added to all diets at the rate of four pounds per hundred pounds of feed. Within a few days most of the affected chicks made a complete recovery. A small number did not recover completely although they showed considerable improvement. These were apparently too seriously affected before the skim milk was added to the ration. This trial was conducted from January 24 to March 13, 1956.

To test the effectiveness of a high-protein ration similar to the one used in trial No. 1, modified to correct apparent deficiencies, a second trial was conducted. Since the more serious difficulties in Trial No.1 were in the groups receiving high-protein with Aurofac, only two rations were used in Trial No. 2 both of which contained Aurofac.

Trial No. 2.

Eighty-day old White Leghorn chicks from one hatching at the Agricultural Institute were randomly divided into eight groups of ten chicks each. These groups were randomly assigned to wire cages. Four groups were randomly assigned to ration diet No. 1 and four groups to diet No. 2 (Table II). The groups were rotated in a systematic order from one cage to another each week to eliminate any possible position advantage. The experiment extended from March 21 to May 2, 1956. Feed and water were given *ad libitum*, to all groups and a small amount of greens was offered daily.

TABLE II

Composition of diets used (Trial No. 2)

Ingredients	Diet	
	No. 1	No. 2
Ground yellow maize	42 per cent	18 per cent
Wheat bran	8 per cent	8 per cent
Groundnut cake	34 per cent	58 per cent
Fishmeal	5 per cent	5 per cent
Dried skim milk	4 per cent	4 per cent
Lucerne leaf meal	3 per cent	3 per cent
Sterilized bonemeal	2 per cent	2 per cent
Lime stone	1 per cent	1 per cent
Salt	0·5 per cent	0·5 per cent
Shark-liver oil	0·5 per cent	0·5 per cent
Manganese sulfate	5 oz. per ton	5 oz. per ton
Aurofac (aureomycin, vitamin B_{12})	4 oz.	4 oz.
Total protein ($N \times 6{\cdot}25$)*	23·4 per cent	31·6 per cent

*Determination made by Chemistry Department of Allahabad Agricultural Institute.

Results and Discussion

A summary of the data obtained on rate of growth and gain per pound feed fed in Trial No. 1 is shown in Table III. When fed with the 'normal-protein' ration Aurofac gave a highly significant increase in growth rate of chicks to six weeks of age and an increase which was significant at the ·02 per cent level of probability at seven weeks. When fed with the 'high-protein' ration, Aurofac gave a highly significant increase in growth rate with chicks to four weeks of age. After four weeks, feeding Aurofac gave no significant growth stimulus with the 'high-protein' ration.

Table III

Effect of "normal" and "high-protein" rations with and without Aurofac upon rate of growth and feed efficiency of Rhode Island Red chicks up to seven weeks of age

Protein	Aurofac pp/cwt.	Average weight at indicated period (g. m.)					Feed per lb. gain
		Start	2 wks.	4 wks.	6 wks.	7 wks.	(lb.)
22·37	0	38·9(45)	66·3	129·7	280·0	354·4(34)	5·00
22·37	0·25	39·0(45)	76·6[a]	165·3[a]	363·1[a]	440·2(41)[b]	4·15
30·56	0	38·2(45)	76·9	174·7	355·0	439·4(39)	4·05
30·56	0·25	38·7(45)	89.9[a]	207·3[a]	367·6	437·5(40)	
22·37	0	38·9(45)	66·3	129·7	280·0	354·4	
30·56	0	38·2(45)	76·9[a]	174·7[a]	355·0[a]	439·4[b]	

( ) Indicates number of chicks.
a-P ·01 b-P ·02 c-P ·05
Significance determined by "t" test. (Snedecor 1946).

The 'high-protein' ration without Aurofac gave a highly significant increase in growth rate over the 'norma-lprotein' ration to six weeks of age. The difference in weight at seven weeks was significantly higher for the chicks receiving the high-protein ration.

The 'high-protein' ration with Aurofac gave a highly significant increase in growth rate over the 'normal-protein' ration with Aurofac for the first four weeks of feeding. There was no significant difference in the sixth and seventh weeks.

Analysis of variance of average weight of twenty pens of Rhode Island Red chicks at seven weeks of age

Factor	Degrees freedom	Sum of squares	Variance*
Total	19	63,817·4	
Treatment	3	27,933·4	9,311·1*
Groups	4	5,979·1	1,494·8
Error	12	29,905·9	2,491·9

*F= 3·736 < Sig. *05 level.

There was no significant difference in the number of pounds feed consumed per pound gain by the different groups of chicks [Table III].

Although the mortality rate for the total lot was approximately 15 per cent there was no significant difference in the mortality rate among groups.

Four chicks on the 'high-protein' ration developed beak necrosis. It may have been caused by the high-protein ration sticking in the beak although the number of cases was too small to warrant that conclusion. The amount of lucerne leaf meal was increased to 3 per cent in the rations used in the Trial No. 2. This supplied additional riboflavin and also tended to reduce the stickiness of the high-protein ration.

The data on the average weekly weights of White Leghorn chicks fed on 'normal' and 'high-protein' rations with Aurofac in Trial No. 2 are summarised in Table IV.

TABLE IV

Average weight of White Leghorn chicks fed on normal and high-protein rations with Aurofac

Protein per cent	Aurofac pp/cwt.	Start	Average weight at indicated periods (g m.)				
			2 wks.	3 wks.	4 wks.	5 wks.	6 wks.
23·4	0·25	44·0(40)	86·1	116·4	160·9	201·6	247·8(39)
31·6	0·25	44·3(40)	94·3	140·3[a]	211·1[b]	284·7[b]	364·3[b](39)

( ) Indicates number of chicks.
a-P ·05 b-P ·01
Significance determined by "t" test [Snedecor 1046].

Trial No. 2 was conducted primarily to test whether the improved ration used during the last four weeks of Trial No. 1 would prevent the curled toe paralysis when fed from the first day. Aurofac was used in both rations in order to get as rapid a growth as possible.

The 'high-protein' ration with Aurofac gave a highly significant increase in growth rate over the 'normal-protein' ration with Aurofac when fed to White Leghorns up to six weeks of age. There was no evidence of a deficiency of riboflavin. One chick on the 'normal-protein' ration and one on the 'high-protein' ration died during the six weeks of the experiment. There were no cases of beak necrosis in the Trial No. 2.

SUMMARY

Ten pens of nine Rhode Island Red chicks each were fed on a 'normal-protein' ration and ten similar pens were fed on a 'high-protein' ration containing a higher than normal percentage of groundnut cake to seven weeks of age. Five pens on the normal protein ration and five pens on the high-protein ration received Aurofac at the rate of five pounds per ton of feed (aureomycin 9 grams and vitamin B_{12} 9 milligrams).

The 'high-protein' ration gave a highly significant increase in growth to six weeks of age and a significant increase to seven weeks of age over the 'normal-protein' ration.

Aurofac added to the 'normal-protein' ration gave a highly significant increase in growth to six weeks and a significant increase to seven weeks over the same ration without Aurofac.

Aurofac added to the 'high-protein' ration gave a highly significant increase in growth to four weeks over the same ration without Aurofac. Addition of Aurofac to the 'high-protein' ration gave no significant difference in growth to six and seven weeks of age.

In a Trial No. 2 with 40 White Leghorn chicks on the 'normal-protein' ration and 40 on the 'high-protein' ration both containing Aurofac, there was a highly significant difference in growth to six weeks in favour of the high-protein ration

There was no significant difference in feed efficiency or in mortality rate.

On the basis of two trials with Rhode Island Red and White Leghorn chicks a 'high-protein' ration containing a higher than normal amount of groundnut cake and less maize gave significantly higher growth rates than a commonly recommended 'normal-protein' ration. Addition of Aurofac to 'normal' and 'high-protein' rations gave an increased growth stimulation. With the 'high-protein' ration costing less than the 'normal-protein' one, it was more economical to feed the 'high-protein' ration.

ACKNOWLEDGMENT

The authors acknowledge the kindness of Lederle Laboratories (India) Ltd., Bombay, in furnishing the Aurofac used in this experiment.

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CHICK FEEDING TESTS

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(With 6 Text-Figs.)

TWO chick-feeding tests were conducted during the period from May 9 to July 3, 1957 at the Delhi State Model Poultry Farm.

The purpose of the two tests was (i) to determine the optimum level of fishmeal to use as a protein supplement in combination with groundnut cake, and (ii) to determine the maximum level of groundnut cake which can be used in a starting ration as a replacement for more expensive grains.

The lowest prices quoted recently to the Delhi Poultry Farm, for grains and other ingredients which are used in poultry rations are as follows :

	Rs.
Groundnut cake	7·25/maund
Fishmeal	740/Long ton*
Ground maize	12·69/maund
Bajra (millet)	14·44/maund
Wheat bran	6·37/maund
Ground barley	11·25/maund
Shark-liver oil	21·50/Gallon

*Rs. 26·4/maund

These prices indicate the cost advantage of using the maximum level of groundnut cake and the minimum level of fishmeal.

Materials and Method

Each experimental comparison consisted of four lots of 45 chicks, each divided between an equal number of S. C. White Leghorns and Rhode Island Reds. The chicks were confined to brooders and wire-floored runways without access to yards throughout the test period of eight weeks. Both water and feed were kept before the chicks at all times. Limestone grit was fed from 4 weeks on and finely chopped green feed after two weeks.

The complete ration for each lot is given in Table I.

TABLE I

Ration for test chicks

Ration No.	1	2	3	4	5	6	7	8
Pen No.	1	2	3	4	5	6	7	8
Ingredients (Pounds)								
Fish meal	*0*	2½	*5*	7½	5	5	5	5
Groundnut cake	25	25	25	25	*20*	*30*	*40*	*50*
Bajra	20	20	20	20	30	*20*	*10*	*0*
Ground barley	20	20	20	20	12½	12½	12½	12½
Ground maize	15	15	15	15	14½	14½	14½	14½
Wheat bran	10	10	10	10	10	10	10	10
Dried skim milk	5	5	5	5	5	5	5	5
Skark-liver oil	2	2	2	2	2	2	2	2
ICI mineral mix	2	2	2	2	2	2	2	2

RESULTS

The results secured from these tests are given in Table II.

TABLE II

Data from rationed chicks

Ration No.	Kind of ration	Av. Wt. at 4 wks. (oz.)	Av. Wt. at 8 wks. (oz.)	No. died to 8 wks.	Feed Cons. per lb. Wt. gain	Remarks
1.	No Fishmeal	3·8	7·3	6	8·00	
2.	2½ per cent	5·0	10·2	1	5·35	
3.	5 per cent	4·7	9·7	5	6·21	Most loss during first 10 days. No specific symptoms.
4.	7½ per cent	4·2	10·6	7	5·90	
5.	Gr. nut cake 20 per cent	4·3	10·8	2	5·80	
6.	30 per cent	5·1	10·9	2	5·69	
7.	40 per cent	5·1	11·2	1	5·57	Paralysis and riboflavin deficiency symptoms in lot 8.
8.	50 per cent	5·4	12·9	9	5·67	

Discussion

It will be noted that up to 4 weeks of age the 2·5 per cent level of fishmeal gave a growth rate exceeding the 5 and 7½ per cent level and 32 per cent in excess of the no fishmeal lot. At 8 weeks of age there was no appreciable difference in weight between the three lots containing the different levels of fishmeal but the lot containing 2½ per cent fishmeal now weighed 39 per cent more than the lot with no fishmeal.

Since almost all of the mortality in these lots occurred during the first week or 10 days of the test, it is not believed that any significance should be attached to the mortality. It should be noted, however, that the lowest loss (only 1 chick) occurred in the 2½ per cent fishmeal-level lot. The fishmeal used came from the Director of Fisheries, Bombay.

The groundnut cake replaced *bajra* (millet) in the ration with levels of 20, 30, 40 and 50 per cent. There was slight but consistant increase in growth rate with each increase in groundnut cake level. The average weight for the 50 per cent level lot was 25 per cent heavier at 4 weeks than for the 20 per cent level lot and almost 20 per cent heavier at 8 weeks of age.

Curled-toed riboflavin-like deficiency symptoms showed up in the 50 per cent groundnut cake level lot at about 4 weeks and caused about half of the mortality. The mortality of only 1 and 2 chicks per lot, or approximately 2 and 4 per cent, in the other three lots was exceptionally good considering the weather conditions under which the tests were conducted.

It is recognised that these chick weights are abnormally low in comparison with reported U. S. growth rates, but the difference may be explained by a lack of antibiotics in the rations and the unfavourable weather conditions under which the tests were conducted. Temperature readings in the experimental house showed as high as 108°F at one time with a minimum of 81°F during the test period.

Figs. 1, 2, 3, 4, 5 and 6 show the average weights of chicks on different diets.

Conclusions

1. Fishmeal-level tests should be conducted on other lots of fishmeal but the results secured in these tests prove conclusively that at least 2½ per cent of fishmeal of the quality used will very markedly increase the growth rate of chicks when added to a ration containing 20 per cent groundnut cake and 5 per cent dried skimmed milk as the principal sources of protein.

2. An increase of the fishmeal level from 2½ per cent to 5 and 7½ per cent caused a slight decrease in growth to 4 weeks and an inconsistent influence at 8 weeks.

3. Mortality increased from 1 to 5 and 7 chicks out of the 45 started at the 2½, 5 and 7½ per cent levels of fishmeal respectively, but, since almost all of this mortality occurred during the first week or 10 days of growth, it was not believed that the mortality trend had any significance.

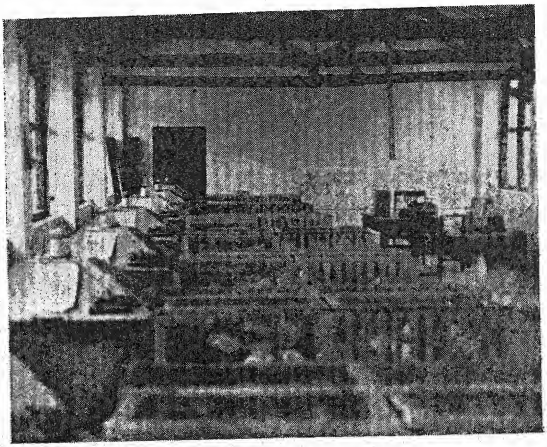

Fig. 1. General view of experimental facilities used

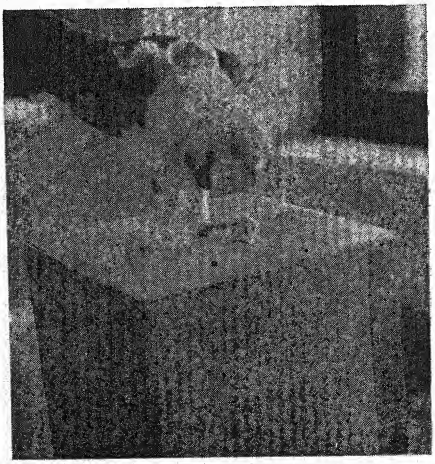

Fig. 2. Curled-toed paralysis which showed up in 50 per cent groundnut cake lot

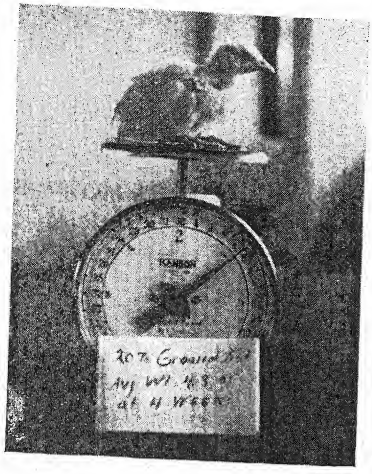

Fig. 3. Average chick at 4 weeks from the 20 per cent groundnut-cake lot

Average weight—4·3 oz.

Fig. 4. An average chick at 4 weeks from the 50 per cent groundnut-cake lot

Average weight—5·4 oz.

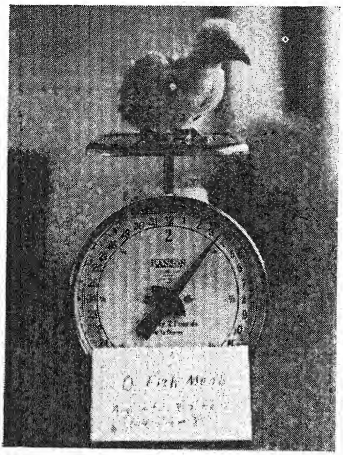

Fig. 5. An average chick from the O fishmeal lot at 4 weeks of age

Average weight—3·7 oz.

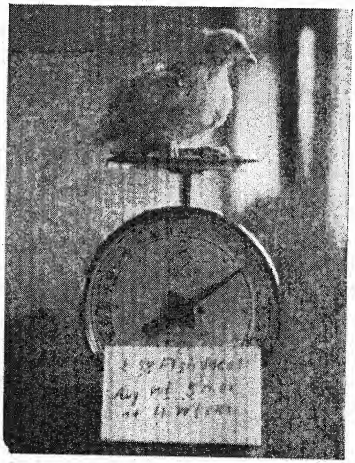

Fig. 6. An average chick from the 2·5 per cent fishmeal lot at 4 weeks of age

Average weight—5 oz.

4. Replacing *bajra* with the less expensive feed ingredient, groundnut cake, at 20, 30, 40 and 50 per cent levels caused a slight consistent increase in growth rate, with the 40 per cent level lot weighing 25 per cent and 20 per cent respectively more than the 20 per cent groundnut-cake lot at 4 and 8 weeks of age.

5. A curled-toe riboflavin-like deficiency symptom showed up in the 50 per cent groundnut-cake lot, causing mortality of about 5 chicks.

6. It is concluded from these tests that at least 40 per cent groundnut cake can be added to chick rations with a saving in feed cost and an increase in growth rate. Higher levels than 40 per cent should be tested further before recommendations are made.

VESPA CINCTA FABR.—A PREDATOR OF THE HIVE BEES AND ITS CONTROL

By M. S. Subbiah, and V. Mahadevan, Agricultural College and Research Institute, Coimbatore

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THE yellow banded wasps *Vespa spp.* are serious pests of the Indian honey bee *Apis indica*. F. in South India. These are predatory in habits and carry off the worker bees in great numbers from the hive entrances. Adults of *Vespa* coming under the category of social wasps living in colonies, are seen all over South India.

Two species were recorded, as predators, one, the common yellow banded wasp-*Vespa cincta*. F.—occurs mostly in plains; Ramakrishna Iyer [1923] has described in brief the nest and the nesting habits of this wasp and Ramachandran, [1952] has mentioned this as a predator of the Indian honey bee. The other species, is slightly smaller collected at Burliar at an elevation of 2,500 ft. above the mean sea level. This was kindly identified by the Chief of the Division of the Entomology, New Delhi as *Vespa tropica var. haematodes* Beq.

Their nests are built inside cracks, cavities or hollows in dilapidated walls, old trees, inside thick cane stools, etc. The adult wasps are very ferocious and if disturbed sting badly.

Preying habit

At Coimbatore, the adult wasps are observed hovering over the hives in numbers from June to December. They frequent the hives on cool cloudy mornings in numbers, and alight on the projecting baseboards in front of the hives and wait for the bees as they go in or out of the hives. The alighting board provides a very convenient place for the wasps to wait for stray unwary workers. At the opportune moment, the wasp pounces on the bees and flies off with its prey and returns a few minutes hence. The depredations of these wasps coupled with low-breeding during that period of the year reduces the strength of the activity of the colony considerably. The colony gets weakened. These wasps concentrate on such dwindling colonies until the colony attacked either perishes or deserts.

Control

The usual method of control is to spot out the nests in the vicinity where these wasps are prevalent and destroying them by smoking after dusk. According to Gonch [1919] the distance that *Vespa* will fly to attack a hive has been found to be 5 miles in a straight line and [3rd Ent. Meeting, Pusa, Vol. II, 781]. Parathion spray at 0·05 per cent directed towards the nest after sunset did not give quick relief. Wasps were seen coming out of such sprayed nests even after 3 or 4 days. Fumigation with calcium cyanide is found to be easier, efficient and causes instant and complete mortality of the wasps.

It is not always easy to spot out the nests ; in some instances they are located in inaccessible localities, not convenient for the fumigation. Here the best thing is to net the adult wasps that fly around the apiary with hand nets and destroy them. This is, however, tedious and costly, and has to be carried out vigilantly for over long periods. From the observations on the habits of these wasps, it is seen that they first alight on a convenient spot on the alighting board of the hive and wait for an opportunity to catch the worker at the hive entrance. Based on these observations, the body in a few hives were pushed to the very front of the base board, thereby not providing any space in front either for the bees or the wasps to alight on returning to the hives or before taking off for pasturage. It was observed that the wasps did not enter the hives where the hive bodies were pushed to the very front, while they continued to snatch off the bees from the hives having the usual space in front to serve as alighting board for the bees. Hence it is suggested that, in addition to the destruction of wasps in their nests wherever possible, the bee keepers will do well to protect their bee colonies from these wasps by pushing the hive bodies to the very front of the base boards.

ACKNOWLEDGMENT

The authors thank Shri K. P. Ananthanarayanan, Government Entomologist for having gone through the paper and for suggestions. They also thank Chief of the Division of Entomology, Indian Agricultural Research Institute, New Delhi, for having identified the newly recorded wasp collected at Burliar.

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A NOTE ON THE OCCURRENCE OF AN ARACHNID—*ELLINGSENIUS INDICUS* CHAMBERLIN—INFESTING BEE HIVES IN SOUTH INDIA

By M. S. Subbiah, V. Mahadevan and R. Janakiraman

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(With 1 Text Figure)

DURING the course of examination of bee colonies at Kotagiri and Burliar (at elevations of 6500 ft. and 2500 ft. respectively above mean sea level on the Nilgiris) a number of specimens of a certain species of a chelifer, otherwise known as pseudo-scorpions was observed lurking inside the hives. The full grown creature Fig 1. is about 8 mm. long and dark brown in colour. Younger ones are also found on the base boards amidst debris and dirty particles; these are pale white in colour. Both the adults and nymphs were found clinging on to the adult worker bees close to the neck.

Specimens of the pest collected from Kotagiri were identified at the Indian Zoological Museum, Calcutta as belonging to the order, *Chelonethi*; family, *Cheliferidoe*; species *Ellingsenius indicus* Chamberlin.

Though the extent of the harm done by these creatures to the bees is not exactly known, it is certainly a hinderance to the foraging activities of bees as they are obliged to carry extra weight of the pseudo-scorpions clinging to them. Hence the general activities of such bees decrease and the affected colony dwindles in the course

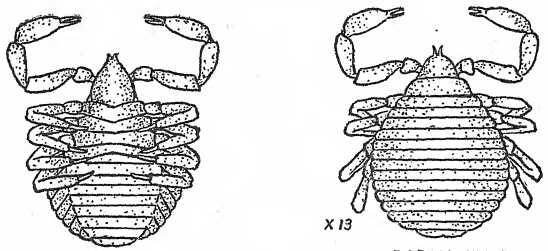

Fig. 1. Ventral and dorsal view of *Acanthasyis* Siva

of time. In a few instances the pest was so great that it brought about the total death of workers in certain hives at Kotagiri. When wild colonies are hived, there is no indication of their presence anywhere in the combs or on the bees, but in a few days a number of them are seen moving about inside the bee hive. How and from where they have got into the hive is not known.

A number of them were brought to Coimbatore for purposes of rearing, but they failed to breed. In laboratory cages provided with debris and bees daily the chelifers were noted to live up to 2 to 6 days. Ten specimens were introduced into one of the working colonies at Coimbatore, but only two of them survived in it. They lived for 2 months 20 days and 3 months 6 days respectively. Those kept in empty tubes without debris or bees lived for 10 days only. Young caterpillars of the wax moth—*Galleria mellonella* and honey bee eggs were given as food for the chelifer, but these did not thrive.

It may be possible to reduce the infestation by chelifers by frequent cleaning of base boards.

Chelifers are noted in large numbers on hill variety bees ; but occasionally these were also noted on plain variety at Coimbatore at an elevation of 1200 ft. above mean sea level.

ABSTRACTS

The use of the Milk Ring Test in a survey of the incidence of bovide brucellosis in southern Scotland. Forguson, G. S. and Robertson, A. (1954) *J. Hyg.* CAMBRIDGE, 52(1). 24-36

THE authors have reported the results of the study on 'Milk Ring Test', undertaken with the object of (i) examining the relationship of ring-test reactors to blood-serum titres and to actual infectivity of milk, (ii) using the ring-test reaction as a criterion to investigate the extent of brucellosis in dairy herds in Southern Scotland and (iii) to studying the incidence of *Br. abortus* in raw milks supplied to the city of Edinburgh and country of Midlothian.

The preliminary tests carried out in two herds free from *Br. abortus* infection showed that the ring test, when applied to milks of normal character was very accurate. The results of ring test of abnormal milk, due to mastitis or drying-off, showed it to be positive in three cases out of twelve doubtful reactors to blood-serum test.

In another herd, four animals giving a doubtful reaction on blood-serum test proved negative to milk ring test, and it was assumed that the doubtful blood-serum reaction was due to vaccination. Taking the serum agglutination test as the criterion and considering only the samples which were negative or positive to the test, the ring test agreed with the blood test in 97·2 per cent of 281 cases. By adopting the other method where the doubtful reactors to either test were classified as positive, the results showed that the ring test disagreed with the blood test in 6·7 per cent of 297 cases. The authors were of the view that the majority of the doubtful reactors would have become negative on retesting.

In testing bulk milk samples the authors found that positive milks continued to give positive reaction even when highly diluted with negative milk. In performing the test for the purpose of routine diagnosis the examination of bulk milks of about ten cows was considered to be safe procedure. Abnormal milk was recommended to be excluded from the routine test, although in bulk samples the milk of such animals had little or no effect on the results of the tests.

In testing *Brucella*-infected milk, a high percentage of ring test positive milks showed negative reaction to guineapig serum agglutination test, but in no case was infection found in ring-test negative milk samples.

The authors observed that ring test was correct in some 93 per cent positive cases and that it was a simple time-saving and accurate screening test for detecting herds possibly infected with *Brucella*.

In view of the high incidence (at least 10·5 per cent) of *Br. abortus* infection in Edinburgh milk supplies in spite of the vaccination programme with Strain 19, the authors were of the view that there was a need to investigate more fully the efficacy of Strain 19 vaccination in reducing the incidence of *Brucella* infection in milk. (B.R.S.)

The role of carbohydrates in urea utilisation, cellulose digestion and fatty acid formation. I. J. BLESCO. (1956). *J. Anim. Sci.*, 15, 426-503

INVESTIGATIONS were carried out to explore the role of various carbohydrates on urea utilisation and the differences in production and distribution of the fatty acids produced from the fermentation of these energy sources. The usual artificial rumen technique was employed and the systems were maintained in an inert atmosphere at a constant temperature of 39°C and at a fermentation *p*H of 6·2 to 6·9 for a specified period. The samples were then analysed for their urea, ammonia and fatty acid contents after suitable intervals. It has been reported that utilisation of urea by micro-organisms *in vitro* was dependent on the amount and type of carbohydrates used as the energy source. Urea utilisation was slightly more with starch as compared to cellulose, xylan and pectin. It has been further reported that the formation of volatile fatty acids and their distribution was also dependent on the amount and the type of carbohydrate employed. Starch gave the highest amount of fatty acid produced and was followed by dextrose and then by cellulose. Digestion of cellulose was markedly retarded when higher doses of dextrose were used. On the other hand, addition of starch up to 1 per cent of the medium in combination with 1 per cent cellulose enhanced the rate of digestion of cellulose and fatty acid formation. Starch, however, when used alone as carbohydrate source, resulted in marked increase in valeric acid concentration with a corresponding decrease in propionic acid formation. [P.C.S.].

Fluctuation within a day in the liver-fluke egg-count of the rectal contents of cattle. W. DORSMAN. (1956). *Vet. Rec.* Vol. 68, No. 34, 571-574

FAECAL egg-count is the usual criterion employed for the diagnosis of disease caused by helminths, the estimation of the degree of subclinical worm infestations and the determination of the efficacy of anthelmintics. However, the interpretation of the results of such counts is often found difficult owing to variations in the faecal egg-contents of the same animal at different times. The faecal egg-count of cattle suffering from severe trichestrongylidosis was found by Messerli to vary from several hundreds to zero within a few days. Spedding observed highly significant variations in the nematode egg-content of sheep faeces collected at two, three, or four-hourly intervals and also in those collected from day to day.

The author studied during April and September, 1955, the variations from hour to hour in the number of eggs of *Fasciola hepatica* in the rectal contents of housed and grazing cattle at Rotterdam, Holland. The faecal samples were collected by manually induced defaecation. Whenever possible only the last few hundred grammes of the dung which passed out of the rectum were used for determining the eggs per gramme of faeces. The results obtained were highly remarkable and unexpected. There was a gradual rise in the egg-count during the morning which reached the peak near 1·30 p.m. and was followed by a gradual descent during the afternoon. During the night the egg-count was found to remain constant at the minimum value of 5 e.p.g. from 8-30 p.m. to 7-30 a.m. It is not yet understood whether the variations are the result of some physiological process of the host or a fluctuation in the egg-laying capacity of the flukes. (H.D.S.)

w studies on comparative Brucella immunity with agglutinogenic and nonagglu-inogenic vaccines. FRANCISCO SIEIRO. (1954). *Am. J. Vet. Res.* XV, pp. 417-424

THE author has attempted to evaluate the immunising values of nonagglu-tinogenic Brucella strain 'B' (Rosenbusch) and the strain 19 (B.A.I.). Clean ifers of 12 to 14 months of age were divided in three groups. Animals of group ' were administered vaccine prepared from the strain 19, those of group 'B' were ren vaccine prepared from the nonagglutinogenic strain " B " and those of group ' were left as unvaccinated controls. Six months after vaccination the heifers re allowed to be covered by clean young bulls and only those heifers which became egnant were used for further study.

The pregnant animals of each of the 'A', 'B' and 'C' groups were divided into o sub-groups, A_1 consisting of 6, and A_2 of 9 ; B of 21, B_2 of 21, and C of 11 and of 8 heifers. Those of sub-groups A_1, B_1 and C_1 were given an infective dose of rulent Brucella culture consisting of 5 million organisms, the mean pregnancy riod of the groups being 162, 202 and 160 days respectively. Those of the sub-oups A_2, B_2 and C_2 were given a higher infective dose consisting of 50 million ganisms and the mean pregnancy periods being 172, 200 and 174 days respectively.

Necessary bacteriological and serological tests were carried out to find out the fection due to the exposure, to the organism. The final criterion of infection as established by the isolation of the infective organism from the placenta or from ie foetal organs or by the rising of the post-partum agglutinins to titres of 1 : 100 : higher.

Judged by the standard mentioned above, it was found that 50 per cent of the imals of the sub-group A, and 47·6 per cent of the animals of the sub-group B, were mune while 81·8 per cent of the control group C, aborted. The infective dose, the sub-groups A_2, B_2 and C_2 was rather very high, that only a small percentage the vaccinated animals of either group was found to be immune and all the con-ol animals were infected.

Even though the results achieved are somewhat more favourable to the use of rain 19 (B.A.I.) the author prefers the use of nonagglutinogenic strain " B " (Rosen-usch) for routine vaccination of animals so that reaction due to natural infection n be easily detected. He advocates the use of both the vaccines in heavily infected eas, strain 19 (B.A.I.) for calfhood vaccination and strain " B " for revaccination id for vaccination of adult females. (M.N.)

itrogen utilisation by lambs fed purified rations containing urea, gelatin, casein-blood fibrin, and soybean protein. ELLIS, W. C., GARNER, G.B., MUHRER, M.E., AND PFANDER, W.H. (1956), *J. Nutrition*, **60**, 413-425

AMBS were fed purified nitrogen free rations consisting of cellulose, starch sugar, lard, minerals and vitamin A and D. Nitrogen was supplemented solely and individually by urea, gelatin, casein, bovine blood fibrin, and a purified soybean rotein. These rations contained approximately 7 per cent of crude protein and pplied 3·6 therms of calculated gross energy per day.

On nitrogen-free ration the mean endogenous nitrogen level was 31·9 mg. N per kg. body weight and the mean metabolic nitrogen level was 2·39 mg. N per gram of dry matter intake or 7·17 mg.N per gram of dry matter excreted. Metabolic nitrogen expressed on the basis of excreted dry matter was less variable than when expressed on the basis of dry matter intake.

There was no significant difference in the true digestibility of nitrogen from any of the nitrogen sources. It varied from 82·0 per cent in urea to 86·5 per cent in casein (metabolic nitrogen being expressed on excreted dry matter basis).

Marked differences were obtained between the daily nitrogen balances for lamb fed nitrogen from various sources. Lambs fed urea stored less nitrogen ($P<0·01$) than those fed any of the true proteins.

The biological values of bovine blood fibrin and soybean protein were significantly larger ($P<0·05$) than that of casein, and the casein values were significantly larger ($P<0·01$) than those of gelatin and urea. The mean biological values of the nitrogen sources were : bovine blood fibrin, 83·1 ; soybean protein, 82·4 ; casein, 72·7 ; gelatin, 57·4 ; and urea 53·7. In calculations metabolic nitrogen was based on excrete dry matter.

Statistically, the ruminal ammonia concentrations varied only slightly with different nitrogen sources with the exception of urea. The ruminal ammonia concentrations after feeding urea were significantly larger than ammonia concentrations associated with any other nitrogen source. (A.W.Z.)

The effect of high levels of an antibiotic on laying chickens during hot weather. BURT W. HEYWANG. (1956). *Poult Sci.* Vol. 35(6) p. 1196—1200 Refs. 4 Tables 5

GROUPS of White Leghorn pullets, selected on previous trapnest records, except in one experiment, were put under four feeding experiments, during 100 or 112 days of hot weather. Two White Leghorn males were in each group during the last three experiments.

The control group was on unsupplemented all-mash based ration. The experimental groups were fed on basal mash mixed and supplemented with crystalline chlortetracycline hydrochloride at two levels of 50 mg. and 100 mg. per ton of mash.

The data collected, correlated and statistically analysed were on egg-production, diet consumption, diet consumption per dozen eggs laid and maintenance of weight by the layers in different groups. Hatchability of fertile eggs and mortality figures were noted. Insufficient data were also recorded in two experiments of 168 days and 84 days of cooler or relatively moderate weather.

At both the levels of supplemented feeding of the antibiotic the egg production showed an increase during the hot weather. The combined average rates of production in the first three experiments were 36·5 per cent for controls, 44·8 per cent for 50-gram level and 47·2 per cent for 100 gm. level. At 50-gm. level these figures for control and experimental were 34·9 per cent and 44·3 per cent respectively when all the four experiments were combined. This increased effect was marked more in poor layers than in good-layers, as seen from two experiments. Whether the

lower level of feeding was as affective as the higher level, could not, however, be proved for want of sufficient data. This increase in egg production was not accountable by increased diet consumption. In fact the quantity of diet consumed per dozen eggs was actually decreased by the supplement. There was practically no significant effect on hatchability of fertile eggs, maintenance of live weight or mortality.

Further data, although insufficient, indicated a similar trend of results during cooler weather experiments. (A. K.).

The effect on fertility of changes in the composition of the normal egg-yolk citrate semen diluent. D. R. MELROSE and D. L. STEWART (1956). *Brit. Vet.* Vol. 112, No. 12, 536-540

IN order to determine whether a reduced electrolyte concentration in the semen diluent or the addition to it of fructose, had, besides a beneficial effect on survival, any influence on the fertility of the spermatozoa preserved at 5°C, the undermentioned diluents were investigated into with the usual 3·6 per cent sodium citrate egg-yolk diluent as control:

(1) Isotonic (2·9 per cent) sodium citrate egg-yolk buffer

(2) Usual 3·6 per cent sodium citrate egg-yolk buffer with the addition of fructose

(3) Bicarbonate-glucose buffer evolved by Kampschmidt

Semen samples were collected every 3rd day and suitable ones were diluted at the rate of 1 : 50 in the control and trial diluents on a split sample basis. After dilution, the semen was cooled to and stored at 5°C. First inseminations were carried out on the day of collection and during 2 days thereafter.

(1) In 3792 inseminations with the isotonic semen diluent, a conception rate of 64·1 per cent was obtained compared to 63·5 per cent in 3831 inseminations with control diluents. There was no significant difference between diluents in the overall conception rate but an improved conception rate was obtained with the isotonic diluent on the 2nd day of use at 5 per cent level of significance.

(2) Addition of 0·05g. fructose per 100 ml. of diluent did not affect the conception rate.

(3) Notwithstanding the better survival of spermatozoa *in vitro*, a lowered conception rate of 63·9 per cent was obtained in 3409 inseminations with the bicarbonate glucose egg-yolk diluent, as against 66·9 per cent conception rate in 3488 inseminations with the control diluent. The difference in fertility was significant at 1 per cent level. (P.R.V.N.)